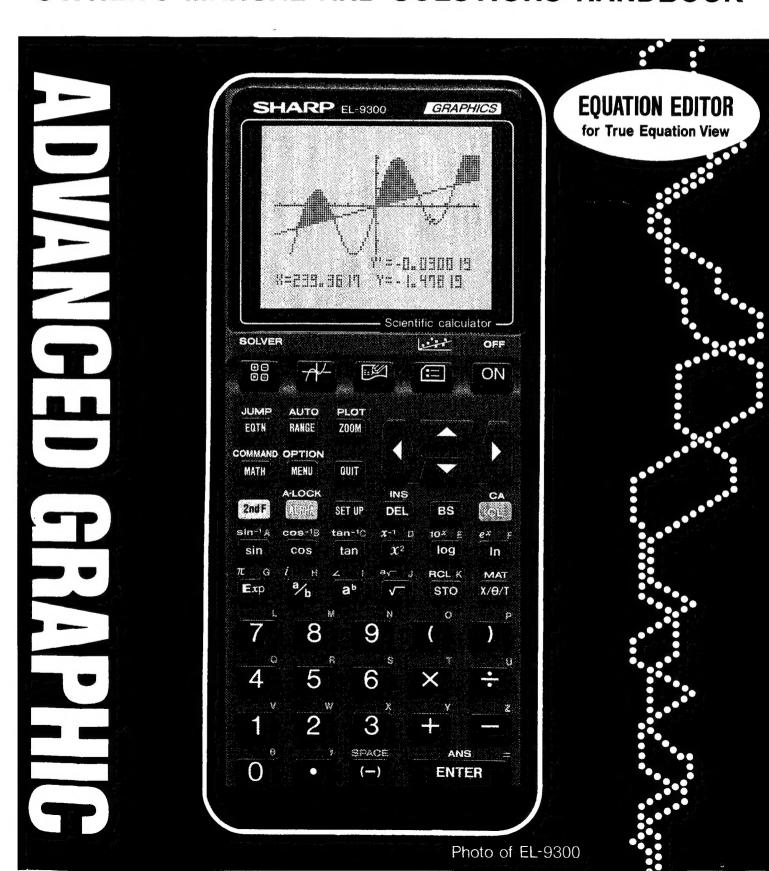
SHARP® EL-9200/9300 GRAPHING SCIENTIFIC CALCULATOR

OWNER'S MANUAL AND SOLUTIONS HANDBOOK





Sharp EL-9200 and EL-9300 Graphing Scientific Calculators

Owner's Manual and Solutions Handbook

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Congratulations!

The Sharp EL-9200 and EL-9300 Graphing Scientific Calculators continue in the Sharp tradition of providing the maximum computing power for your money. With a large number of functions and sophisticated graphing features, this calculator will assist you for many years to come.

Here are a few of the calculator's powerful features:

- Graphs. You can graph functions in rectangular or polar coordinates. You can also graph parametric equations.
- Equation editor. Calculations appear on the screen as they do on paper. The calculator remembers the last 110 keystrokes in calculation mode and you can go back and edit any of them (even after you've turned the calculator off and on again).
- Statistics. Entering statistics data is easy, and you can graph six different kinds of statistics graphs and six different regression curves.
- Programs. Your calculator is programmable, so you can automate and store common calculations. All the commands you need are in menus or on the keyboard.
- Solver. With the EL-9300's equation solver, you can solve advanced equations quickly and easily.
- User-friendly interface. You can select menu operations with the cursor keys or by keying-in letters and numbers.
- Memory. There is plenty of memory to store equations, programs, and statistics.
- Built to last. The calculator is ruggedly constructed and has a sliding front cover to protect your investment.

About this manual

This section describes the contents of this manual, the notational conventions used in the text, and how to use this manual effectively.

Chapter overview

This manual contains the following chapters:

- Chapter 1 − *A Quick Tour* explains the calculator's keys, the display, the menu system, and the operating modes.
- Chapter 2 *General Information* explains how to set up the operating environment, and how to use the option menu.
- Chapter 3 Using the Calculator explains how to use the calculator in normal operating mode (calculation mode).
- Chapter 4 Graphing explains the graphing functions.
- Chapter 5 *Programming* explains how to program the calculator.
- Chapter 6 Using Statistics explains the statistical functions.
- Chapter 7 Graphing Statistics explains the statistical graph functions.
- Chapter 8 Solving Equations explains the solver functions of the EL-9300.
- Chapter 9 Getting Results shows how to solve different types of problems from various disciplines.

The appendices contain battery replacement information, a list of error messages, a command index, and general specification information.

Conventions used in this manual

The following conventions are used throughout this manual:

The keys on the the calculator appear in a box: 2ndF

Key operations appear as follows:

 x^{-1} D x^2

D is the hexadecimal number D (or the letter D, if pressing ALPHA) is not required)

ALPHA D is the letter D

2ndF (x^{-1}) is x^{-1}

 x^2 is x^2

MENU D is menu selection D

Words or numbers displayed on the screen appear as follows: RAD

How to use this manual

The Sharp EL-9200 and EL-9300 Owner's Handbook is both a reference book and a tutorial of how to solve some common problems.

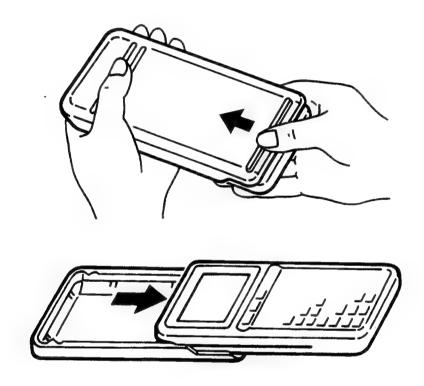
For quick reference, use the table of contents in the front of the manual. Also provided is an alphabetical index.

This manual is a straightforward step-by-step guide to using your calculator.

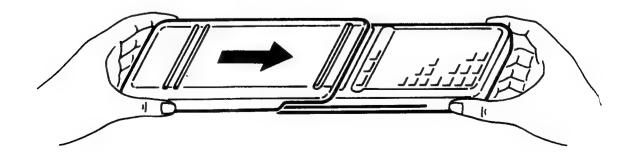
The protective cover

Your calculator is supplied with a cover to protect the keyboard and display when the calculator is not in use.

Before using the calculator, remove the cover as shown.



When you are not using the calculator, slide the cover over the top of the calculator as shown.

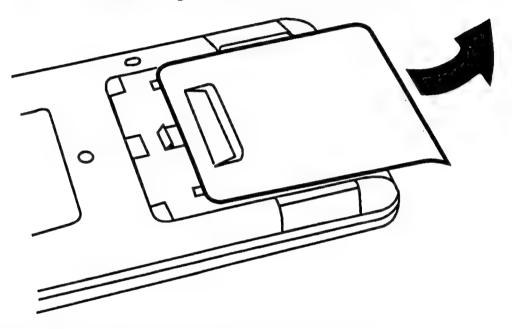


The first time you use the calculator

The calculator uses four AAA batteries. Before using the calculator for the first time, you must install the batteries and reset the calculator.

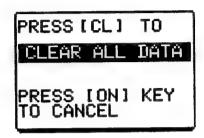
Install the batteries as follows (for a detailed description of how to install the batteries, see Appendix A):

Slide off the battery compartment cover as shown.



- 2. Remove the battery plate by sliding it to the left.
- 3. Insert the batteries into the battery compartment (put the minus (-) ends in first against the springs). Make sure each battery is inserted in the correct direction, as shown on the inside of the compartment.
- 4. Replace the battery plate by sliding it back into its original position.
- Replace the battery compartment cover.

6. Use the tip of a ball-point pen to press the reset button on the back of the calculator. The reset button is near the upper right corner of the battery compartment. The following message appears:



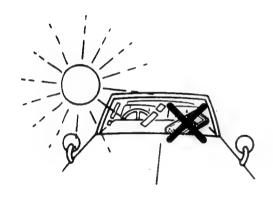
If you don't see this message, the batteries may have been inserted incorrectly; try again (repeat steps 1 through 6).

- 7. Press CL and then press any key. (this will erase any previous data if present)
- 8. Check that REAL MODE and 0. are displayed.
- 9. Adjust the display contrast until you can see the display clearly. Press 2ndF OPTION and press + or until the contrast is set correctly, then press QUIT.

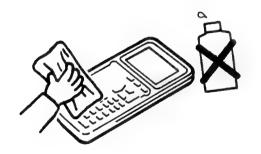
Caring for your calculator



Do not carry the calculator around in your back pocket, as it may break when you sit down. The display is made of glass and is particularly vulnerable.



Keep the calculator away from extreme heat such as on a car dashboard or near a heater, and avoid exposing it to excessively humid or dusty environments.



Clean with a soft, dry cloth using no solvents.



Do not use a sharp pointed object or exert too much force when pressing keys.



Avoid excessive physical stress.

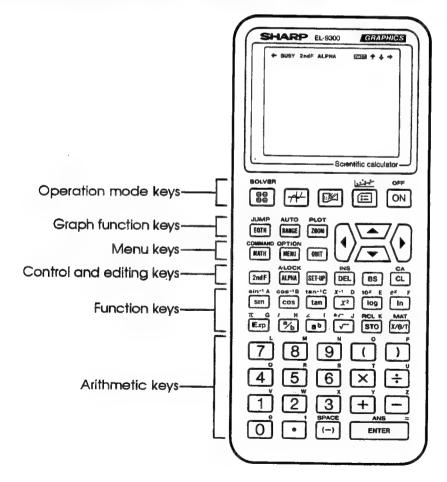


CHAPTER 1:

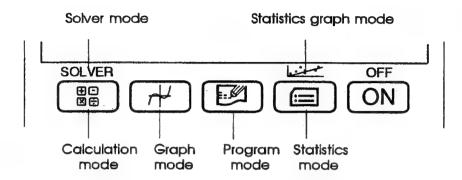
A Quick Tour

This chapter covers the basics, such as: turning the calculator on, entering numbers, correcting mistakes, using simple arithmetic operation keys, using <code>2ndF</code> and <code>ALPHA</code>, and using the menu system. It also gives you an overview of each of the operating modes, and tells where to find more information.

The keys of the calculator



The top row contains keys that determine the operation mode of the calculator:



Note: Solver mode is available only on the EL-9300.

Turning the calculator on and off

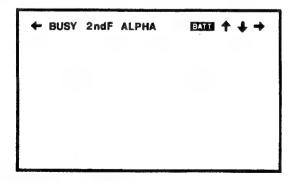
To turn on the calculator, press ON. To turn the calculator off, press 2ndF OFF. To conserve the batteries, the calculator turns itself off automatically if not used for several minutes.

If the calculator is performing a time consuming function and you want it to stop, press ON and the function is halted.

Note: When the calculator is turned off, ↓ appears momentarily while 2ndF OFF is pressed.

The display

Several small words in the top of the display indicate different states of the calculator.



If the **Simu** indicator appears, the batteries need to be changed right away. In the EL-9300 there is a backup battery that retains the calculator's data

while you are changing the batteries. For a detailed description of how to change the batteries, see Appendix A.

Getting a fresh start

The simplest mode to begin with is calculation mode (real). To operate in calculation mode press Make sure the calculator is set to real mode, press MENU 1.

Note: Unless otherwise noted, all examples in this manual assume you are in floating point display format. This is the default display format. Changing the format is described in Chapter 2.

Entering numbers

Enter numbers using the number keys ① through ⑨, the decimal point key ①, and the change-sign key ①.

Example:

Enter the number 123.4

Press:

123.4 ENTER

Result:

123.4

Note: Throughout the rest of this manual, numbers in examples are not shown in boxes.

The enter key

ENTER tells the calculator to perform the operations entered in the display. The 2ndF key allows you to select the second function of a key. Pressing 2ndF ANS ENTER recalls the last result displayed.

Example:

Divide 11 by 16

Press:

11 (+) 16 (ENTER)

Result:

0.6875

Now take the sine of the result:

Press:

sin 2ndF ANS ENTER

Result:

0.63460708 (radians)

The change-sign key

The (-) key changes the sign of the number about to be entered in the display.

Example:

Enter -38.

Press:

(-) 38 ENTER

Result:

-38.

Note:

The minus — key is not the same as (-). Pressing any of the arithmetic keys before entering a number operates on the last displayed result.

Using exponents

Your calculator displays up to 10 digits in its result display; however, it always retains 14 digits in memory. Numbers that cannot be represented with 10 digits are displayed in scientific notation.

In scientific notation, numbers are represented as a mantissa and an exponent. For example, the number 39250 is written in scientific notation as 3.925×10^4 , 3.925 is the mantissa and 4 is the exponent.

Enter numbers using exponents as follows:

■ Enter the mantissa. If the mantissa is negative, press (-) before entering the mantissa.

■ Press the exponent key Exp and enter the exponent. If the exponent is negative, press (-) before entering the exponent.

Example:

Enter 4.535×10^{-17} .

Press:

4.535 Exp (-) 17 ENTER

Result:

4.535E-17

If you make a mistake while entering the exponent, simply backspace with BS (or) and enter the correct number.

Example:

Enter 7.4×10^{12}

Press:

7.04 Exp 13

Oops! Wrong exponent.

Press:

BS 2 ENTER

12 replaces 13.

Result:

7.04E 12

Uh-oh. Mantissa is wrong too.

Press:

2ndF A 4 4 DEL ENTER

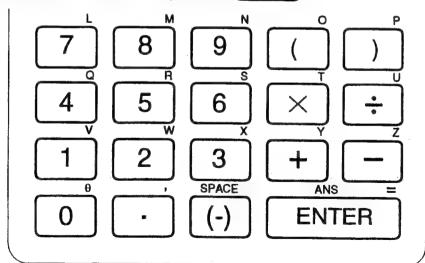
Result:

7.4E 12

Note: BS deletes characters as it backs up, ■ does not.

Simple arithmetic

Simple calculations use the arithmetic operation keys (+ - x ÷), the parenthesis keys, the number keys, and ENTER.



Simple calculations are entered from left to right as they appear on the written page.

Example:

 $5 + 3 \times 4 \times 2$

Press:

5 + 3 x 4 x 2 ENTER

Result:

The calculator performs multiplication before addition to arrive at the above result. Arithmetic precedence is described at the beginning of Chapter 2.

Decimals (for example 981.8) are entered just as they appear on the written page using ... Common fractions are entered using ... or ... or ...

Example:

 $981.8 \times \frac{4}{5}$

Press:

981 . 8 x 4 % 5 ENTER

or 981 . 8 x 4 ÷ 5 ENTER

Result:

785.44

Fractional results can be displayed three different ways. See "Answers" in Chapter 2 for more details.

Correcting mistakes

Mistakes are remedied in several ways. The remedy depends on the type of mistake.

The cursor keys

Incorrect keystrokes may be changed by using the cursor keys.

Example:

Enter 345174

Press:

342174

(A mistake)

Press:

■ ■ 5 DEL ENTER

(To remedy)

Pressing DEL is not required while in overtype mode. For more details, see "Editing" in Chapter 2.

The cursor keys perform the following functions:

Move up one line.

Move to a previous equation (if any). If within a menu, the cursor moves to the top of the menu.

▼ Move down one line.

Move to the next equation (if any). If within a menu, the cursor moves to the bottom of the menu.

Move one space to the left.

2ndF Move to the start of an equation.

Move one space to the right.

2ndF ► Move to the end of an equation.

Use , , and to edit within equations. The cursor changes shape depending on its location within an equation. Normally the cursor is an underline (). When the cursor is a vertical bar or block, it is within a function or equation. Move out of a function with or .

You can use the cursor keys to edit equations after you've pressed ENTER while the answer is still in the display. After you've entered another equation, you must use 2ndF \(\blacktriangle \) to edit a earlier equation. You can move up and down through the equations you've entered with 2ndF \(\blacktriangle \) and 2ndF \(\blacktriangle \).

¹ The following keystrokes are remembered (and can be edited) while in calculation mode. If you change modes, the keystrokes are removed from memory.

	EL-9300	EL-9200
In one line	160	128
In equation editor	114	91

Clearing errors

Syntax errors in equations and results that are too large to display or are not defined produce errors.

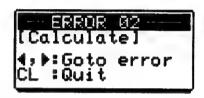
Example:

 $5 \div 0$

Press:

5 ÷ 0 ENTER

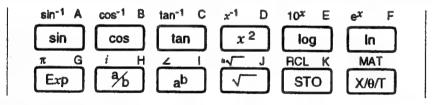
Result:



Pressing or moves the cursor to the error. Pressing CL clears the error.

Function keys

The following drawing shows the two rows of standard function keys:



In general, enter functions as if you were writing them on paper.

Example:

 $log(37^2)$

Press:

log 37 x² ENTER

Result:

3.136403448

The order of operation is described in Chapter 2.

Storing to memory

You can store and recall numbers in 27 different memories (A-Z and θ). You don't have to press ALPHA after pressing the STO: alpha mode is entered automatically, and the ALPHA indicator appears on the display.

Example:

Store 123 to memory Z

Press:

123 STO Z

Press 2ndF RCL letter to recall a number stored in memory. You do not need to press ALPHA before pressing the letter, and the ALPHA indicator appears on the display.

Example:

Recall Z

Press:

2ndF RCL Z

Result:

123.

You can use the stored number without using [2ndF] [RCL].

Example:

Multiply Z by 3

Press:

3 ALPHA Z ENTER

Result:

369.

The variable key $X/\theta/T$

The variable key $X/\theta/T$ lets you enter a capital X, θ , or T. The variable entered depends on the coordinate system selected (SETUP) choose rectangular [X], polar[θ], or parametric [T]). The default mode is rectangular, so $X/\theta/T$ enters an X.

Second functions, alpha functions, and menu functions

The normal function of a key is printed on the cap of the key. Many of the keys also have second functions and alpha functions.

Using [2ndF]

A function printed above a key in yellow is the second function of that key. Press [2ndF] before you press a key to use its second function. When you press [2ndF], the 2ndF indicator appears at the top of the display. If you press 2ndF) by mistake, simply press 2ndF again and the indicator disappears.

Example: Compute sin⁻¹(1)

(Notice that sin⁻¹ is the second function of sin.)

Press: SET UP B 1 ENTER 2ndF sin-1 1 ENTER

Result: 90. (degrees)

Using [ALPHA]

A character printed above a key in blue is the alpha function of that key. Press ALPHA before you press a key to use its alpha function.

After you press ALPHA, the ALPHA indicator appears in the top of the display to remind you that the next key you press enters its alpha function. If you press [ALPHA] by mistake, simply press [ALPHA] again and the indicator disappears. Pressing [2ndF] [A-LOCK] locks the calculator in alpha mode until [ALPHA] is pressed.

Example: Enter the letter A.

(Notice that A is the alpha function of sin.)

Press: ALPHA A

Result:

selects degrees

The math key

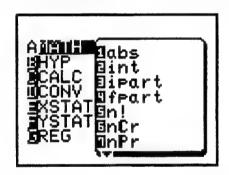
Each mode of the calculator has functions assigned to MATH. When you can't find a math function you want on the keyboard, press MATH, and math functions available in the selected mode appear.

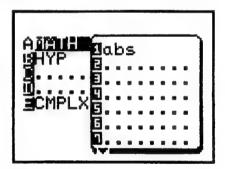
Use the cursor keys to select different menu headings, or press the letter that precedes the heading. Use the cursor keys and press **ENTER** to select a function in a submenu, or key-in the number that precedes the function you want.

Note: It isn't necessary to press ALPHA before pressing a letter that selects a menu heading.

The available functions in the MATH menu depend on what mode you are using. For example:

In real mode MENU 1 MATH: In complex mode MENU 4 MATH:





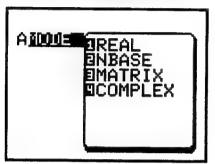
Functions that are not available are shown as dotted lines.

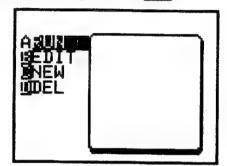
The menu key

In general, when MENU is pressed, operations for the current mode appear. The operations that appear depend on what mode you are using. For example:

In calculation mode MENU:

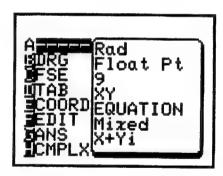
In programming mode ::





The set up key

Pressing SET UP displays settings that change the way results are calculated or displayed.



The current settings are displayed on the right. Options B through H let you change the angular units, the display format, the number of decimal points, the graphing coordinate system, screen editing mode, how fractional answers are displayed, and complex coordinates. For more information, see Chapter 2.

Operating modes

The EL-9200 has five operating modes: calculation mode, graph mode, program mode, statistics mode, and statistics graph mode. The EL-9300 has a sixth mode: solver mode.

Use the operation mode keys (BB A E 2ndF SOLVER) to enter a mode. Anytime you want to go to a specific mode, press the corresponding mode key and the calculator immediately enters that mode.

Calculation mode

In calculation mode, you have a full range of mathematical functions and features.

Example: Evaluate the following definite integral: $\int_{1}^{3} \sqrt{x^2-1} dx$

Press: SET UP E 1 ENTER MATH C 2

1 ▲ 3 ▶ ▼ X/0/T x² - 1 ▶ MATH 3 ENTER

Result: 3.360942644

Note: When you select functions from the same menu it is not necessary to press the menu letter again.

Example: Convert 123 to hexadecimal.

Press: MENU 2 MATH D 2

123 MATH 1

Result 000000007B

Calculation mode is described in the Chapter 3, "Using the Calculator."

Graph mode [#

Graph mode lets you graph many functions using rectangular, polar, or parametric coordinates.

Example:

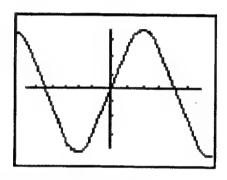
Graph the function y=sin x

Press:

RANGE MENU ENTER QUIT

sin X/0/T 2ndF AUTO

Result:



Graph mode is described in Chapter 4, "Graphing."

Program mode lets you write programs on your calculator.

Example:

Write a program that asks you to enter X and Y

coordinates, converts them to polar coordinates, and

then displays them on the screen.

Press:

C ENTER 1

POLAR ALPHA ENTER

2ndF COMMAND A 3 X/0/T ENTER

2ndF COMMAND A 3 ALPHA 2ndF Y ENTER

2ndF A-LOCK 2ndF X , 2ndF Y ALPHA

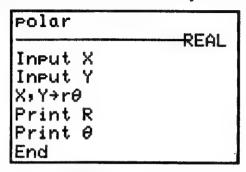
MATH D 3 ENTER

2ndF COMMAND A 1 ALPHA 2ndF R ENTER

2ndF COMMAND A 1 ALPHA θ ENTER

2ndF COMMAND A 6 ENTER

The finished program should look exactly like this:



To run the program press MENU A, select the program with the cursor keys and press ENTER, or key-in the number that precedes the program.

Example:

Use the above program to convert 3,4 to polar

coordinates.

Press:

SET UP B 1 ENTER MENU A

[ENTER] (Select the program)

3 ENTER 4 ENTER

Result:

5.

53.13010235

Program mode is described in Chapter 5, "Programming."

Statistics mode 🗐

Statistics mode lets you enter data for one- or two-variable statistics with (or without) weight. Data can be masked, sorted, stored to a matrix, or recalled from a matrix.

Example:

Find the mean of the following five 100-meter dash

track times: 10.3, 8.9, 9.9, 11.2, 11.0.

Note: If you have already entered statistics data, you must delete it (Press MENUD 2 ENTER) before entering the following commands.

```
Press: 

10.3 ENTER 8.9 ENTER 9.9 ENTER 11.2 ENTER 11

ENTER

MENU A 1

Result: 

\bar{x} = 10.26

5x = 0.923579991

\sigma x = 0.826075057

\Sigma x = 51.3

\Sigma x^2 = 529.75

n = 5.

xmi = 8.9

xma = 11.2
```

Statistics mode is described in Chapter 6, "Using Statistics."

Statistics graph mode [22]

Statistics graph mode lets you graph data entered in statistic mode. There are twelve types of graphs: six kinds of data graphs, and six kinds of regression curves.

Example:

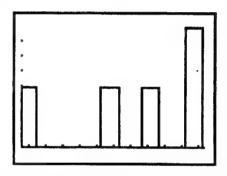
Display a histogram of the track time data from the

previous example.

Press:

2ndF [A 2ndF AUTO]

Result:



Statistics graph mode is described in Chapter 7, "Graphing Statistics."

Solver mode (EL-9300 only) [SOLVER]

Solver mode provides three methods to solve for different variables in equations.

Example:

Solve the for w: $s=(1/z)^*h^*w$

Press:

2ndF SOLVER ALPHA s ALPHA = 1 % ALPHA z

X ALPHA h X ALPHA W ENTER

6 ENTER 3 ENTER 4.5 ENTER ENTER

Result:

w=4.

Solver mode is described in Chapter 8, "Solving Equations."

CHAPTER 2:

General Information

This chapter describes features that affect all modes of the calculator. It covers arithmetic precedence, setup features, and the option menu.

Precedence

The calculator always performs calculations in the proper arithmetic order, which may not be the order you entered them.

If you don't use parentheses to specify the order of calculation, the calculator uses the following precedence:

PRECEDENCE	OPERATION
Highest	Operations in fractions
	Complex angle calculations (θ in $r \angle \theta$)
	Functions that follow an entry (for example, $n!$, x^2 , x^{-1}) The first part of a^b
	Implied multiplication with π or a variable (for example, 4π , $6X$)
	Functions that precede an entry (for example, sin, log)
	Implied multiplication with a function (for example, 5 sin, 2 ln)
	nPr, nCr ×, ÷ +, – AND
	OR, XOR, XNOR
	$\rightarrow xy, \rightarrow r\theta$
Lowest	⇒ (storing to memory), =

High precedence operations are performed before low precedence operations. Operations of the same precedence are performed in the order they are entered. Operations within parenthesis are always performed first.

Example:

 $9+5 \times 4$

Is calculated in the following order:

5 x 4 is multiplied first, then 9 is added to the product.

Press:

MENU 1 (Enter real calculation mode.)

9 + 5 x 4 ENTER

Result:

29.

Example:

 $5 + 6 \times \log 100$

Is calculated in the following order:

The log of 100 is multiplied by 6 and 5 is added to the product.

Press:

5 + 6 x log 100 ENTER

Result:

17.

Parentheses

You may specify the calculation precedence by using the parentheses ((() and ())). Parentheses are entered as they would appear in a written equation. Expressions within parentheses are always computed first.

Example:

 $(9+4) \times 5$

Press:

(1) 9 (+) 4 (1) (x) 5 (ENTER)

Result:

65.

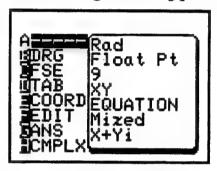
Once you press (), parentheses are considered open until closed by pressing () or ENTER.

Parentheses may be nested up to 32 levels deep. The calculator allows up to 32 pending operations and stores up to 14 numbers.

The set up menu

The set up menu lets you change the angular mode, the display format, the graphing coordinate system, editing mode, the way fractional results are displayed, and the way complex numbers are displayed.

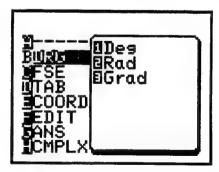
After pressing SET UP the following menu appears:



This displays the current settings of all of the set up options. The current setting for each option is shown to the right of the option heading.

Degrees, radians, grads

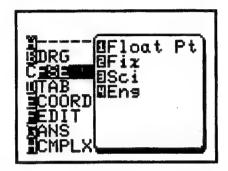
EDRG lets you select angular units (degrees, radians, or grads) for trigonometric functions. After pressing **SET UP B**, the following menu appears:



Press 1, 2, or 3 to select degrees, radians, or grads, respectively. A circle is divided into 360 degrees, 2π radians, or 400 grads.

Display formats

■FSE (which stands for Fixed-Scientific-Engineering) lets you select one of four different display formats. When you press SET UP C the following menu appears:



IFloat Pt sets the display format to floating point which uses only the number of decimal places required to display a number. Up to 10 significant digits can be displayed.

EFix sets the display format to fixed point which displays numbers with a fixed amount of decimal places. Results are rounded off to the correct number of decimal places. (TAB sets the number of digits that follow the decimal point.)

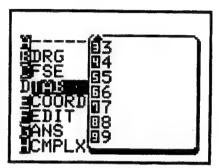
ESci sets the display format to standard scientific notation. For example, the number 39256 would be written 3.9256x10⁴ and displayed as 3.9256 E 4. The mantissa is displayed to the left of the letter E, and the exponent is displayed to the right of the letter E. (TAB sets the number of displayed decimal places in the mantissa.)

■ Ens sets the display format to engineering notation which is similar to scientific format except that the exponent is always a multiple of 3. The mantissa ranges from 1 to 1000 instead of 1 to 10. For example, the number 39256 would be displayed as 39.256 E 3. (TAB sets the number of displayed decimal places in the mantissa.)

If a number is too large or too small to be displayed in a selected format, scientific notation is used.

Decimal places

MTAB changes the number of decimal places for fixed point, scientific notation, and engineering units. Press **SET UP D** and the following menu appears:



Use the cursor keys to highlight the desired number of decimal places (0-9) and press ENTER (or simply press 0-9).

TAB has no effect when FSE is set to Float Pt.

The number of decimal places affects the results from the modify command (mdf). For more information, see "Conversions" in the next chapter.

Rounding

Frequently, the calculator must round a number to display it in the selected format. However, the calculator retains the more precise version of the number internally. This way the calculator minimizes most rounding errors.

Example:

At a fixed display of 6-decimal places,

divide 5 by 9.

Press:

SET UP C 2 D 6 ENTER (Selects Fix, 6-decimal

places)

5 ÷ 9 (ENTER)

Result:

0.55556

Example:

Change the number of decimal places to 2.

Press:

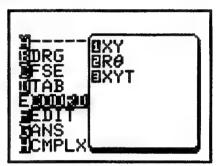
SET UP D 2 ENTER

Result:

0.56

Coordinates

COORD sets the coordinate type used for graphing. Press **SET UP E** and the following menu appears:



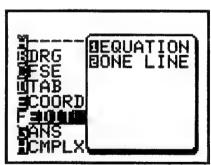
YY selects rectangular coordinates.

 $\blacksquare R\theta$ selects polar coordinates.

E XYT selects parametric equation mode.

Editing

EDIT sets the editing mode of the calculator. There are two editing modes; equation edit mode and one line edit mode. Press **SET UP F** and the following menu appears:



EQUATION selects the equation edit mode (this is the default mode). Equations appear on the screen as they are commonly written on paper. This simplifies the entering and reading of equations. You must exit functions (use) that can operate on more than one number.

Example:

Enter the square root of one-quarter cubed, times the

absolute value of -15 in equation edit mode.

Press:

SET UP C 1 F 1 ENTER

1 % 4 • a 3 • • X MATH A 1 (-) 15

ENTER

The equation will look like this:

$$\sqrt{\left(\frac{1}{4}\right)^3} * |-15| = 1.875$$

Equation edit mode is not available in program mode, nbase mode, or when entering values into fields such as the range screen, a statistics card, or a matrix element.

Equation edit mode always inserts characters when editing equations. To delete characters, press DEL.

Note: The calculator's input response time is slower in equation edit mode. You can continue to enter keystrokes before they are displayed, but the input buffer has a four keystroke maximum.

■ ONE LINE selects one line edit mode. Equations appear in a line as they would on a typical calculator. Equations with more than 16 characters wrap to the next line. Unlike equation edit mode, you do not need to use to exit functions.

Example:

Enter the square root of one-quarter cubed, times the

absolute value of -15 in one line edit mode.

Press:

SET UP F 2 ENTER

(1 % 4) a 3 X MATH 1 (-) 15 ENTER

The equation will look like this:

$$\sqrt{(1_{\rm F}4)^3}$$
 abs -15 = 1.875

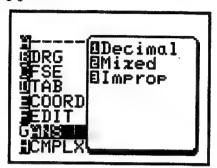
One line edit mode types over characters when editing equations. To insert characters, press 2ndF INS. In overtype mode the cursor is a block: ■. In insert mode the cursor is a triangle: ◀.

When using [%], fractions are displayed $a_{\Gamma}b$.

The calculator's input response time is faster in one line edit mode.

Answers

MANS selects the way fractional answers are displayed. Press SET UP G and the following menu appears:



Decimal sets the calculator to display fractional results in decimal form.

Example:

$$\frac{1}{5}$$
 * 11

Press:

Result:

EMixed sets the calculator to display fractional results as mixed numbers.

Example:

After doing the previous example, show the mixed

result.

Press:

Result:

$$2\frac{1}{5}$$

Elmprop sets the calculator to display fractional results as improper.

Example:

After doing the above example, show the improper

result.

Press:

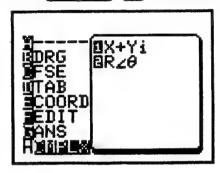
Result:

$$\frac{11}{5}$$

Fractions are displayed differently in one line edit mode.

Complex coordinates

ICMPLX sets the coordinate type used for display and conversion functions while in complex mode. Press **SET UP H** and the following menu appears:



1 X+Yi selects rectangular coordinates.

■ R∠# selects polar coordinates.

To convert from one coordinate system to the other, select the coordinates you want to change to, enter the complex number, and press ENTER. The results obtained from these conversions are dependent on the angular mode.

Example:

Change 45∠30 to rectangular coordinates.

Press:

MENU 4 SET UP B 1 C 1 H 1 ENTER

45 2ndF 2 30 ENTER

Result:

38.971143+22.5i

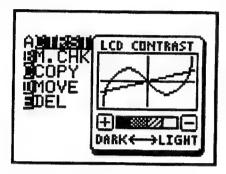
The option menu

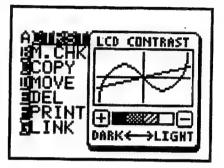
The option menu controls the following functions: display contrast, memory usage, copying and moving files, and deleting data.

EL-9300 only: The option menu also controls printing and linking to other devices.

Contrast

To change the display contrast, press 2ndF OPTION and one of following menus appears:





The EL-9200 option menu The EL-9300 option menu

Note: If you are in calculation, statistics, or statistics graph mode, the copy and move options will not be available.

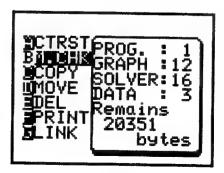
To darken the display contrast press [+].

To lighten the display contrast press [-].

Note: It is possible to lighten the display contrast until the calculator appears to be off. If the calculator display is blank when you press ON, press 2ndF OPTION and + (repeatedly) to darken the display contrast.

Memory check

EM. CHK shows you how much memory is being used for storage, and counts how many programs, graph files, solver files (EL-9300 only), and matrices are stored. Press 2ndF OPTION B and a menu similar to the following appears:



PROG shows the number of stored programs.

GRAPH shows the number of stored graph files.

SOLVER shows the number of stored solver files.

DATA shows the number of stored matrices. If statistics data has been entered, DATA is incremented by 1.

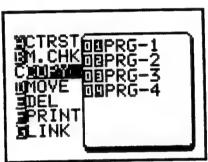
The EL-9200 has approximately 1.8 kilobytes of available memory.²

The EL-9300 has 23 kilobytes of available memory.

For a detailed description of how memory is used, see Appendix D.

Copying files

ECOPY copies files. Press 2ndF OPTION C and a menu similar to the following appears (if you have not created any programs the submenu will appear blank):



² Available memory is the memory not being used by the calculator to store settings, memories, etc.

To copy a file, you must be in the mode that contains the file that you want to copy (for example, you must be in program mode to copy a program).

Example:

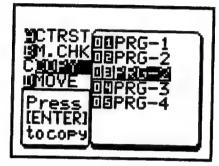
Assuming you have a list of programs stored, copy

program 02.

Press:

2ndF OPTION C 02

The display shows:



Use v and to position the file within the list.

Press:

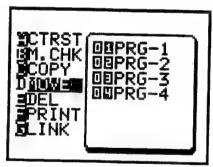
ENTER

Result:

The file is copied.

Moving files

IMOVE repositions a file in a list without making a copy. Press 2ndF OPTION D and a menu similar to the following appears:



To move a file, you must be in the mode that contains the file you want to move (for example, you must be in program mode to move a program).

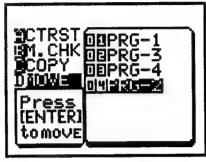
Example:

Move program 02 to be program 04.

Press:

2ndF OPTION D 02 ▼ ▼

The display shows:



Press:

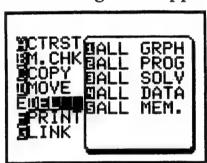
ENTER

Result:

The file is moved.

Deleting files

■DEL deletes all files from a particular mode or clears all memory. Press [2ndF] OPTION [E] and the following menu appears:



BALL GRPH deletes all graph files.

BALL PROG deletes all program files.

EALL SOLV deletes all solver files (EL-9300 only).

EALL DATA deletes all the data stored in matrices and statistics cards.

EALL MEM. deletes all files and all data.

Note: Once a file has been deleted there is no way to recover it, unless it is backed up on another device.

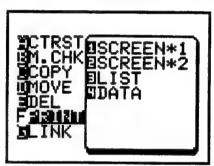
To delete individual files, enter the mode that contains the files you want to delete, and use the mode specific delete function (found in the MENU menu).

Printing

(EL-9300 only)

If your EL-9300 is connected to the SHARP CE-50P Printer, **PRINT** prints the current screen two different ways. You can also list a program, print a stored equation, print all of the data in a matrix, or print the statistics registers.

Press 2ndF OPTION F and a menu similar to the following appears:



Note: In graph, solver, and program mode, DATA is not available. In calculation and statistics mode, LIST is not available.

■ SCREEN*1 prints the current screen of the selected mode on the SHARP CE-50P Printer and Cassette Interface. The print area is 96 dots wide by 64 dots high.

ESCREEN*2 prints the current screen of the selected mode *sideways* on the SHARP CE-50P Printer and Cassette Interface. The print size is twice that of SCREEN *1. Equations that normally scroll off the screen are printed in full.

ELIST lets you select a file from a list for printing. To print a file, you must be in the mode that contains the file you want to print (for example, you must be in program mode to print a program). Solver and graph files written in equation edit mode print in SCREEN*2 format at normal size.

Example:

Print program 02 (assuming you have two programs).

Press:

2ndF OPTION F 3 02

Result:

The program is printed.

■ DATA prints the data stored in a matrix or in stored statistics registers. You must be in calculation mode to print a matrix or in statistics mode to print statistics data.

Note: If you want to print the set up menu, press SET UP 2ndF OPTION. You may have problems printing reverse text, or filled graphs while using the AC adapter (EA-23E) for the SHARP CE-50P. Use batteries in CE-50P, and disconnect the AC adapter.

If an error occurs during printing, ERROR 70 I/O device appears.

Linking to other devices

(EL-9300 only)

ELINK lets you transfer files and data between two calculators (EL-9300), or between a calculator and a cassette tape. Press 2ndF OPTION G ENTER and a menu similar to the following appears:



must have a transfer cable (SHARP CE-300L) that plugs into the bottom of each calculator. (Pry open the small plastic cover.) Both calculators must be in the same mode. You can transfer data in either direction, but during each transfer one calculator must send and the other must receive.

In statistics mode no file or data selection is required, simply select SEND and all of the statistic cards are sent.

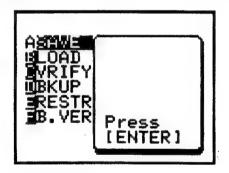
When you transfer data in statistics mode, press on the receiving calculator immediately after the transfer.

LIS. ALL sends the entire stored contents of the current mode. The receiving calculator's memory for the selected mode will be replaced with the sending calculator's memory. A warning message is displayed. Press ENTER to continue with the transfer, press CL to quit.

ERECIV receives files from another calculator. The order that send and receive are pressed does not matter.

MBKUP copies all files, statistics, and matrices to another calculator. Both calculators must be in the same mode. The receiving calculator's memory will be replaced with the sending calculator's memory. A warning message is displayed before the receiving calculator's memory is cleared. Press **ENTER** to continue with the transfer, press **CL** to quit.

If you are connected to the CE-50P and switched on when LINK is selected, the following menu appears:



TSAVE sends all files or data (depending on what mode you are in) from your calculator to a cassette tape through the SHARP CE-50P Printer and Cassette Interface. For the most accurate data transfer, use the AC adapter (EA-23E) for the CE-50P while performing calculator to tape transfers. The calculator prompts you to enter a file name (eight characters or less). Press record and play on the cassette before pressing ENTER. If the remote cable is used, the cassette will start automatically.

BLOAD retrieves files or data from a cassette tape. You must be in the correct mode to retrieve files. (For example, you must be in program mode to retrieve program files.) The calculator's memory will be replaced with the information retrieved from the cassette tape. A warning message is displayed. Press **ENTER** to continue with the transfer, press **CL** to quit.

Note: When restoring from a tape, you must wind the tape to the location of the data and press play. If the remote cable is connected, the tape will start and stop automatically. If you are not using the remote cable, you must start and stop the cassette manually. Be patient, tape transfers may take over 15 minutes. Remember where you stored the data on the cassette tape.

MYRIFY verifies that a file was correctly transferred to the cassette tape.

IBKUP lets you copy all memories from all modes to a cassette tape.

■RESTR restores a back up session from a cassette tape. The calculator's memory will be replaced with the information retrieved from the cassette tape. A warning message is displayed. Press ENTER to continue with the transfer, press CL to quit.

B. VER verifies that the back up session was transferred correctly to the tape.

Example:

Save, verify and then load all of your program files.

First, connect the CE-50P and turn it on. Connect the cables to the cassette player:

EAR to Earphone MIC to Microphone REM to Remote

Make sure the remote switch on the CE-50P is on. Reset the counter on the cassette, and insert a tape.

Press:

2ndF OPTION G ENTER Programs

Press record and play on the cassette.

Press:

ALPHA ENTER

When the transfer is complete, the program menu is

displayed.

Write the start and stop counter numbers and the file name (programs) on the cassette tape.

Now, verify that the transfer was successful.

Rewind the cassette slightly in front of the stored

programs.

Press:

2ndF OPTION G ENTER C ENTER programs

Press play on the cassette.

Press:

ALPHA ENTER

After a few seconds, the calculator will confirm that it has located the program. If the verify is successful, the program menu is displayed. If not, Error 72 appears.

Finally, load the stored files from the tape.

Rewind the cassette slightly in front of the stored

programs.

Press:

2ndF OPTION G ENTER B ENTER

ENTER (To confirm deletion of old programs.)

programs

Press play on the cassette.

Press:

ALPHA ENTER

After a few seconds, the calculator will confirm that it has located the program. If the load is successful, the program menu is displayed.

Cassette troubleshooting

If you are having problems with the cassette, check the following:

Make sure the CE-50P is:

on

connected to the calculator

Switched to remote

powered by fresh batteries or the AC adapter

EAR is connected to the earphone on the cassette

MIC is connected to the microphone on the cassette (you may have to disconnect this during verify and load)

REM is connected to the remote on the cassette

Make sure the cassette's:

volume is set to the 3/4 max

tone is set to the middle

If everything is set up correctly, check if the cassette is wound to the correct spot: press play and listen for a high-pitched sound like a fax signal.

Wind the tape to the correct position. If it still does not work, try a different tape or a different player.

If you are trying to verify data, and you get an error, make sure that no program or matrices were added or changed since you saved the files.

If the calculator can't find the name your looking for, make sure you have the correct name.

Make sure the calculator is in the correct mode, for example, you must be in program mode to receive programs.

Make sure there is enough room on the tape for the files.

Using memories

Your calculator has 27 memories for storage of results of calculations. The memories are identified as A-Z and θ .

The number in the display is copied to memory by pressing STO and a letter.

Note: Do not press ALPHA before selecting a letter for storing or recalling numbers. Pressing STO or RCL automatically activates the alpha feature. An easy way to recall the contents of a memory is by keying-in the letter and pressing ENTER.

General Information

Memories can be accessed in all modes of the calculator and are retained when the power is turned off.

Example:

Store 5 in memory C and store 24 in memory Z.

Press:

5 STO C 24 STO Z

Verify by:

2ndF RCL C

Result:

5.

Press:

ALPHA Z ENTER

Result:

24.

You can use memory locations in equations.

Example:

Multiply Z by 4.

Press:

4 (ALPHA) Z (ENTER)

Result:

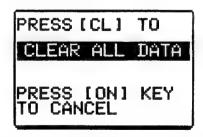
96.

There is one more memory, Ans. Ans always stores the answer from the last calculation. Recall Ans by pressing 2ndF ANS ENTER.

Resetting the calculator

If this calculator is subjected to strong external noise or shock during use, a rare condition may occur in which all keys, including the ON key, do not function. In this case, press the reset switch.

To reset the calculator, press the reset button located on the back of the calculator near the upper right corner of the battery compartment. The following message appears:



If you press [CL], all of the data in the calculator and all memories are erased.

If you press ON the reset operation is cancelled.

CHAPTER 3:

Using the Calculator



This chapter introduces some of the advanced features of your Sharp calculator. It covers the different calculation modes, function keys, and menu functions.

Calculation modes

Calculation mode has four submodes of operation. Change modes by pressing MENU and selecting a new mode. The modes are as follows:

■ Real Normal operating mode.

You can perform calculations using real numbers in this mode.

■ Nbase Binary, octal, decimal, or hexadecimal operating mode.

You can perform base conversions and logical operations in

this mode.

Matrix Matrix operating mode. You can enter matrices and perform

matrix operations in this mode.

■ Complex Complex operating mode. You can enter complex numbers

and perform calculations using complex numbers in this

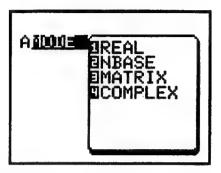
mode.

The calculator stays in the selected mode after the power is turned off.

Real mode

Real mode is used for standard calculations. Real mode has the widest variety of available functions. However, many of the functions described in this section can be used in other modes.

While in calculation mode, press MENU A and the following menu appears:



Enter real mode by pressing 1, or use the cursor keys and press ENTER.

Fractions

You can work with fractions directly, without converting them to decimal form. You can perform calculations using decimal, mixed, or improper fractions.

Entering fractions

Enter common fractions using % as follows:

- 1. Enter the numerator.
- 2. Press .
- 3. Enter the denominator.

If you make a mistake while entering the fraction, you can correct it with or BS (even after you've pressed ENTER).

Example: Ent

Enter the fraction $\frac{367}{465}$.

Press:

SET UP F 1 G 2 ENTER 367 % 465 ENTER

Result:

 $\frac{367}{465}$

Example:

Enter the mixed fraction $5\frac{2}{3}$.

Press:

5 + 2 % 3 ENTER

Result:

 $5\frac{2}{3}$

Converting fractions

You can convert between decimal, mixed and improper fractions by using SET UP and ENTER. See the section called "Answers" in Chapter 2 for more information.

Example:

Enter $398 \frac{4}{10}$ as a mixed fraction then convert to it to

decimal.

Press:

SET UP G 1 ENTER

398 + 4 % 10 ENTER

Result:

398.4

Now convert it to an improper fraction:

Press:

SET UP G 3 ENTER

Result:

1992 5

Return to decimal mode: SET UP G 1 ENTER.

Pi

Pressing 2ndF π enters pi into the display. Only the first ten digits are displayed if you press ENTER, but the calculator uses fourteen digits in calculations.

Example:

Enter π .

Press:

2ndF π ENTER

Result

3.141592654

If you want to see the rest of the digits, subtract 3.141 from π and multiply the result by 10,000 (or change the display format to scientific notation).

The trigonometric functions

You can calculate trigonometric functions (and their inverses) of angles measured in degrees, radians, or grads.

A circle has 360°, 2π radians, or 400 grads.

Selecting angular units

To select degrees, radians, or grads, press SET UP. The angular unit selected is displayed at the top of the list on the right. Change it by pressing B and the number that precedes the desired angular unit.

Sines, cosines, and tangents

The sin, cos, and tan keys calculate the sine, cosine, and tangent of a number. When using these keys, be sure the calculator is set for the angular unit you want.

Example:

Calculate $\sin 30^{\circ}$, $\cos \frac{\pi}{2}$ radians, and $\tan 150$ grads.

Press:

SET UP B 1 ENTER

sin 30 ENTER

Result:

0.5

Press:

SET UP B 2 ENTER

Press:

cos 2ndF π % 2 ENTER

Result:

0.

Press:

SET UP B 3 ENTER

tan 150 ENTER

Result:

-1

The 2ndF sin-1, 2ndF cos-1, and 2ndF tan-1 keys calculate the arcsine (sin-1), arccosine (cos-1), and arctangent (tan-1) of a number. The result is always the smallest (positive or negative) angle that has a sine, cosine, or tangent equal to the number operated on. For example, the sines of -210°, 30°, 150°, and 390° are all 0.5. The arcsine of 0.5 is 30°, the smallest angle whose sine is 0.5.

Example:

Calculate sin⁻¹ -1 in degrees.

Press:

SET UP B 1 ENTER 2ndF sin-1 (-) 1 ENTER

Result:

-90.

Example:

Calculate 2cos⁻¹ 0 in radians.

Press:

SET UP B 2 ENTER

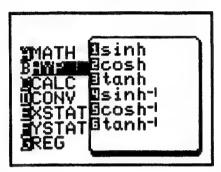
2 2ndF cos⁻¹ 0 ENTER

Result:

3.141592654

Hyperbolic sines, cosines, and tangents

Select hyperbolic trigonometric functions by pressing MATH B. The following menu appears:



Select the desired hyperbolic function by pressing the number to the left of the function.

Example:

Find the hyperbolic cosine of 0.

Press:

MATH B 2 0 ENTER

Result:

1.

Example:

Find the inverse hyperbolic sine of 7.544.

Press:

MATH | B | 4 | 7.544 (ENTER)

Result:

2.718263812

Your calculator has many functions that are selected from menus. See "Math menu functions" later in this chapter for a description of the other math menus.

Power functions

You can perform standard power and root calculations with the x^2 , a^b , 2ndF $\sqrt[a]{}$, and 2ndF x^{-1} keys.

The x^2 key calculates the square of the number in the display.

Example:

Calculate the square of 15.

Press:

 $15 x^2$ ENTER

Result:

225.

BB Using the Calculator

The $\begin{bmatrix} a^b \end{bmatrix}$ key raises a to the power b. Use it as follows:

- 1. Enter the number that you want to raise to a power.
- 2. Press [a^b].
- 3. Enter the exponent, and press **ENTER**.

Example:

Calculate 7 to the 4th power (7^4) .

Press:

7 a 4 ENTER

Result:

2401.

The key calculates the square root of the next number typed on the display.

Example:

Calculate the square root of 27.

Press:

√ 27 (ENTER)

Result:

5.196152423

The 2ndF $^{a}\sqrt{}$ key calculates the a^{th} root of the number. Use it as follows:

- 1. Enter the root.
- 2. Press 2ndF [●]√.
- 3. Enter the number and press **ENTER**.

Example:

Find the fifth root of 243.

Press:

5 2ndF °√ 243 ENTER

Result:

3.

The 2ndF x^{-1} key calculates the inverse of the number in the display. This is the same as $\frac{1}{x}$.

Example:

Calculate the inverse of 0.5.

Press:

0.5 [2ndF] [x-1] [ENTER]

Result:

2.

Logarithms and exponentials

You can calculate common (base 10) and natural (base e) logarithms and exponentials (antilogarithms) using the \log , \ln , 2ndF 10^{2} , and 2ndF e^{2} keys.

The common logarithm key log calculates the base 10 logarithm of a number.

Example:

Calculate the common logarithm of 31.62.

Press:

log 31.62 [ENTER]

Result:

1.499961866

The natural logarithm key in calculates the base *e* logarithm of a number.

Example:

Calculate the natural logarithm of 31.62.

Press:

In 31.62 [ENTER]

Result:

3.453789832

The 2ndF 10^{x} key raises 10 to the power of a number.

Example:

Calculate 10^{4.7}.

Press:

2ndF 10^x 4.7 ENTER

Result:

50118.72336

The 2ndF e^x key raises e to the power of a number.

Example:

Calculate e¹...

Press:

2ndF (ex 1 ENTER)

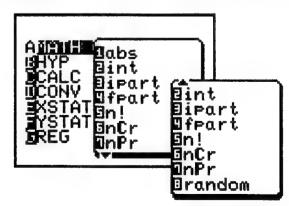
Result:

2.718281828

This is the base number *e*.

Math menu functions

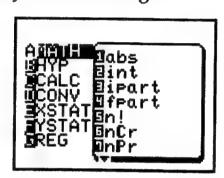
The MATH key displays a math function menu, and each mode has different menus. Some of the functions operate on numbers that appear either before or after the function. Some functions require more than one number, others simply recall values from statistical registers. In calculation mode, after pressing MATH A the following display appears:



Menu headings can be selected with the cursor keys or by keying-in the letter that precedes the heading (you do not have to press ALPHA) first). Menu functions can be selected with the cursor keys or by keying-in the number that precedes the function. For example, to select n!, press 5, or press

Absolute values, integers, factorials, combinations, permutations, and random numbers

Pressing MATH A displays the following:



Babs is the absolute value function. Absolute value can be defined as $\sqrt{x^2}$ for all real x.

Example:

What is the absolute value of -7?

Press:

MATH [A] 1 (-) 7 [ENTER]

Result:

7

Eint returns the greatest integer equal to or less than the given number.

Example:

What is the integer value of -7.94?

Press:

MATH A 2 (-) 7.94 ENTER

Result:

-8.

Eipart returns only the integer part of a given number.

Example:

What is the integer part of -7.94?

Press:

MATH [A] 3 (-) 7.94 [ENTER]

Result:

-7.

If feart returns only the fractional part of a given number.

Example:

What is the fractional part of 7.94?

Press:

MATH [A] 4 7.94 [ENTER]

Result:

0.94

In! calculates the factorial of an integer in the display. A factorial is the product of a given integer multiplied by all positive integers less than itself. For example, 3!=3x2x1=6. (n must be positive. By definition 0!=1.)

Example:

What is 7 factorial?

Press:

7 MATH A 5 ENTER

Result:

5040.

 \exists nCr is the combinations function. This function calculates how many different groups of r items you can make out of n objects. The order of the items doesn't matter. For example, the group Marc, Marilyn, Ted is the same as Ted, Marilyn, Marc.

Example:

How many different 3 person teams can you make out of

a group of 15 players?

Press:

15 MATH A 6 3 ENTER

Result:

455.

 \blacksquare nPr is the permutations function. This function calculates how many different arrangements of r items can be made out of n objects. The order of the items *does* matter. For example, the license plate MHJ is not the same as MJH.

Example:

How many different 3 lettered license plates can you

make out of the first 15 letters of the alphabet?

Press:

15 MATH A 7 3 ENTER

Result:

2730.

The small arrow at the bottom of the menu indicates that some functions are not displayed. These functions can be displayed by using the cursor keys.

□ random is the random function which displays a random number between 0.000 and 0.999.

Example:

Have the calculator pick a number between 0 and 10.

Press:

MATH (A) 8 X 10 ENTER

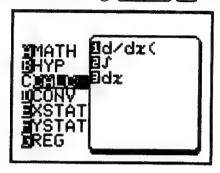
Result:

A number between 0 and 9.99 appears.

The hyperbolic functions under the HYP menu were explained a few pages back. The next section describes the calculus functions.

Calculus functions

Your calculator can integrate and differentiate many types of functions using numerical estimations. Pressing MATH © displays the following:



Id/dx (selects the derivative function. This function estimates the first derivative³ of a function at a given value. The syntax of the derivative function is:

d/dx(function, x [value], Δx [change in x]). (Δx is optional.)

Example:

If $F(x)=x^2+x$, find F'(4).

Press:

MATH C 1 $X/\theta/T$ x^2 + $X/\theta/T$ ALPHA , 4 ALPHA

, 0.00001) ENTER

Result:

9.

$$f'(x) = \lim_{\Delta x \to 0} \frac{f(x + \Delta x) - f(x)}{\Delta x}$$

³ The formula for the derivative of a function is:

Est selects the integrate function. This calculates the area under a curve between two points. The calculator uses Simpson's rule⁴ to partition the area into a number of even subintervals and estimate the answer. The calculator doubles the number of subintervals you specify. The answer is an estimate, and therefore will not be exactly correct.

Example:

What is $\int_0^4 x^2 dx$ calculated over 16 subintervals.

Press:

SET UP F 1 ENTER MATH C 2

0 A 4 X/0/T x²

Displays:

∫₀⁴ ײ _

Press:

ALPHA, 8

(The comma marks the end of the equation, the 8 is one half the number of desired subintervals.)

Note: This step is optional. If no subinterval count is given, a default of 100 subintervals is used.

$$\int_{a}^{b} f(x)dx \approx \frac{b-a}{3n} [f(x_0) + 4f(x_1) + 2f(x_2) + 4f(x_3) + 2f(x_4) \dots + 2f(x_{n-2}) + 4f(x_{n-1}) + f(x_n)]$$

where the closed interval [a,b] is evenly partitioned into n subintervals of length $\frac{b-a}{n}$. This gives an estimate of the area under the curve.

⁴ Simpson's rule can be written:

團 Using the Calculator

Press:

MATH C 3 ENTER

Displays:

Result:

21.33333333

Edx marks the end of an integration equation. The example above demonstrates its use.

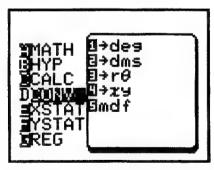
When using the line editor (SET UP F 2) or programming mode () the above integration must be entered like this:

The syntax of integration in line edit mode is:

J Function, lower limit, upper limit, intervals, dx

Conversions

Pressing MATH D displays the following:



■ → des converts a number expressed in degrees minutes seconds (sexagesimal) notation to degrees (decimal).

Example:

What is the value of 7°56′24" in degrees?

Press:

7.5624 MATH D 1 ENTER

Result:

7.94 (7.94°)

□ →dms converts a number expressed in degrees (decimal) to degrees minutes seconds (sexagesimal) notation.

Example:

What is the sexagesimal value of 7.94°?

Press:

7.94 MATH D 2 ENTER

Result:

7.562400 (7°56′24″00)

 $\exists \rightarrow r\theta$ converts rectangular coordinates to polar coordinates.

Example:

What is (1,1) in polar coordinates?

Press:

SET UP B 1 ENTER 1 ALPHA , 1 MATH D 3

Result:

1.414213562

To see θ , press: ALPHA θ ENTER

Result:

45.

Polar coordinates are automatically stored in R and θ . The value of θ depends on the angular units selected.

☐ →xy converts polar coordinates into rectangular coordinates.

Example:

What are the rectangular coordinates of (4,90)?

Press:

SET UP B 1 ENTER 4 ALPHA , 90 MATH D 4

Result:

To see Y, press: ALPHA Y ENTER

Result:

The rectangular coordinates are automatically stored in X and Y.

I mdf is the modify function. When the calculator displays a value, it rounds the displayed version of the number to the selected number of decimal places. However, the calculator stores a more precise version of the number internally.

When you select mdf, the stored value is replaced with the displayed value. This function is only useful for decimal numbers.

Example:

What is $(1+3) \times 3$?

Press:

SET UP C 2 D 2 ENTER

1 ÷ 3 ENTER (0.33 is displayed) X 3 ENTER

Result:

1.00

團 Using the Calculator

Now do it again, but this time modify the displayed value.

Press:

1 ÷ 3 ENTER (0.33 is displayed)

MATH D 5 X 3 ENTER

Result:

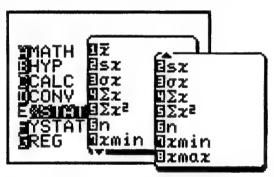
0.99

Return to floating point notation, [SET UP][C][1][ENTER].

Statistics in calculations

Note: If data has not been entered in statistics mode, none of the following statistical variables are meaningful and may cause errors when used in equations.

In calculation mode you can use results from data entered in statistics mode. Statistics mode is explained in Chapter 6. The following single-variable statistical results are available in calculation mode:



These variables are defined as follows:

 $\mathbf{D}\mathbf{z}$ mean value of x data.

 $\exists \exists x$ sample standard deviation of x data.

 $\mathbf{E} \boldsymbol{\sigma} \mathbf{x}$ population standard deviation of x data.

 $\square \Sigma z$ sum of x data.

 $\mathbf{E} \mathbf{\Sigma} \mathbf{x}^2$ sum of the squares of the x data.

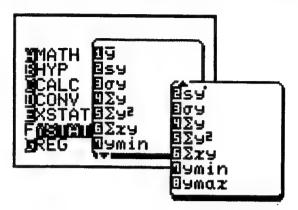
5 n number of observations.

minimum x value.

Exmax maximum x value.

Variables appear in equations as variables, not numbers. A number is returned only after **ENTER** is pressed.

The following two-variable statistical results are available in calculation mode:



These variables are defined as follows:

mean value of y data.

sample standard deviation of y data.

population standard deviation of y data.

■ Σ⊌ sum of y data.

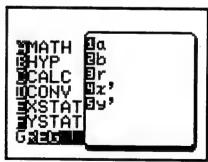
 $\Box \Sigma \Box^2$ sum of the squares of the y data.

Sum of the products of the xy pairs.

minimum y value.

□ ymax maximum y value.

The following regression results are available in calculation mode:



These variables are defined as follows:

first coefficient of linear regression (y-intercept).

second coefficient of linear regression (slope).

- **B**r sample correlation coefficient.
- Estimated value of x, based on a given value of y, using linear regression. You must enter a y-value before using this function. The syntax is: given y-valuex' (for example, 5x' returns an x-value based upon a y-value of 5).
- Estimated value of y, based on a given value of x, using linear regression. You must enter an x-value before using this function. The syntax is: given x-valuey' (for example, 25y' returns a y-value based upon an x-value of 25).

Note: The regression variables available in calculation mode are always based on linear regression.

Nbase mode

While in calculation mode, press MENU A. Enter nbase mode by pressing 2, or use the cursor keys and press ENTER.

Nbase mode lets you calculate and perform logical operations in binary (base 2), octal (base 8), decimal (base 10), and hexadecimal (base 16). In binary mode, the only active number keys are 0 and 1. In octal mode, the numbers 0 through 7 are active. In decimal mode, 0 through 9 are active. In hexadecimal mode, the numbers 0 through 9 and the letters A through F represent 0 through 15. (You don't have to press ALPHA) to use these letters.)

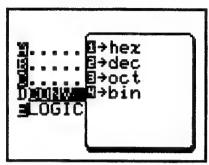
Only integer values are represented in hexadecimal, octal, and binary modes. The ... key is ignored by the calculator and exponents are not active.

The maximum value of a number in hexadecimal and octal modes is limited to 10 digits. The maximum value of a number in binary mode is limited to 16 digits.

Negative numbers are represented in two's complement notation (the complement of the number plus 1).

Selecting bases

After entering nbase mode, press MATH and the following menu appears:



You can convert a number in the display into the selected base (if the number can be converted). If the number cannot be converted an error results. The conversion function places the calculator in the new base mode. For example, selecting the first option sets the calculator to hexadecimal mode. The calculator remembers the selected base when you leave nbase mode or turn off the calculator.

Example: Convert 214(base 10) to hexadecimal then to binary.

Press: MENU 2 MATH D 2 214 MATH D 1

Result: 0000000D6 (In hexadecimal, now convert it to binary)

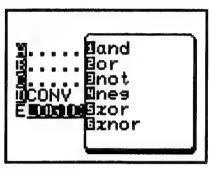
Press: MATH 4

Result: 000000011010110

The calculator is now in binary mode.

Logical operations

Your calculator performs six logical operations. The logic menu appears when you press MATH [E]:



B and is defined as follows:

х	1	1	0	0
у	1	0	1	0
x AND y	1	0	0	0

AND compares the binary digits of two numbers and returns a 1 for each matching pair of 1's. For example, 101010 AND 111000 equals 101000. AND compares them as follows:

x 101010 y 111000 x AND y 101000

Example:

In hex mode, what is C AND 9?

Press:

MATH D 1 C MATH E 1 9 ENTER

Result:

0000000008

Bor is defined as follows:

Х	1	1	0	0
у	1	.0	1	0
x OR y	1	1	1	0

OR compares the binary digits of two numbers and returns a 1 for each 1 found. For example, 101010 OR 111000 equals 111010. OR compares them as follows:

x 101010 y 111000 x OR y 111010

Example:

In hex mode, what is C OR 9?

Press:

MATH D 1 C MATH E 2 9 ENTER

Result: 000000000D

Enot is defined as follows:

х	1	0
NOT x	0	1

NOT switches each binary digit of a number to the opposite binary digit including leading zeros. The number (NOT x) is the complement of x. For example, NOT 101010 equals 1111111111010101. NOT inverts the digits as follows:

x 000000000101010

NOT x 11111111111010101

Example: In hex mode, what is NOT C?

Press: MATH D 1 MATH E 3 CENTER

Result: FFFFFFFF3

BB Using the Calculator

Ines converts a number to negative. Since the calculator displays negative numbers in two's complement notation, NEG inverts the number (like NOT) and then adds 1.

NEG switches each binary digit of a number to the opposite binary digit including leading zeros and then adds 1. For example, NEG 101010 equals 111111111010110. NEG inverts the digits as follows:

x 000000000101010 invert 1111111111010101 and add 1 +1

x NEG 1111111111010110

Example: In hex mode, what is NEGC + C?

Press: C MATH D 1 MATH E 4 C + C ENTER

Result: 0000000000

Exor is defined as follows:

х	1	1	0	0
у	1	0	1	0
x XOR y	0	1	1	0

XOR (exclusive OR) compares each binary digit of two numbers and returns a 1 when either digit contains a 1, but not both. For example, 101010 XOR 111000 equals 010010. XOR compares them as follows:

y 101010 y 111000

x XOR y 010010

Example: In hex mode, what is C XOR 9?

Press: MATH D 1 C MATH E 5 9 ENTER

Result: 000000005

Expor is defined as follows:

Х	1	1	0	0
у	1	0	1	0
x XNOR y	1	0	0	1

> x 101010 y 111000 x XOR y 010010 NOT!=

x XNOR y 1111111111101101

Example:

In hex mode, what is C XNOR 9?

Press:

MATH D 1 C MATH E 6 9 ENTER

Result:

FFFFFFFFA

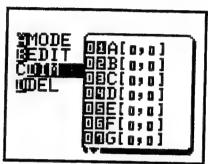
Matrix mode

Matrix mode lets you perform matrix operations and define matrix elements.

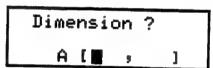
While in calculation mode, press MENU A. Enter matrix mode by pressing 3, or use the cursor keys and press ENTER.

Defining a matrix

After entering matrix mode, press MENU C and the following menu appears:



This option lets you define (and store) up to 26 different matrices. The matrices are stored even after the mode has been changed or the calculator has been turned off. To define the dimensions of a matrix, press 01 (or use the cursor keys to select a matrix and press ENTER). The following display appears:



Note: Redefining a matrix that already exists erases all of the information in that matrix. If you don't want to erase an existing matrix, press QUIT and select a different matrix.

Enter the number of rows and the number of columns. For example, to define a matrix with four rows and three columns, press 4 ENTER 3 ENTER.

The first column of the matrix appears:

	+
M[1,1]=	0.
A[2,1]=	υ.
A[3,1]=	0.
	0.
A[4,1]=	a
	٥.

Use the keypad to enter the matrix elements and press ENTER. Each element of the matrix is labeled with its associated coordinate (matrix index [row number, column number]). Use the cursor keys to move around the matrix (through the row and column elements). Arrow indicators show you which directions you can move. and move through the rows. and move through the columns. You can enter numbers, variables, and equations for each matrix element. (The final calculated value is stored.) Press QUIT to exit the matrix.

Example: Find the determinant of: $\begin{vmatrix} 1 & 3 \\ 2 & 4 \end{vmatrix}$ Press: MENU C O 1 2 ENTER 2 ENTER (Defines a 2x2 matrix)

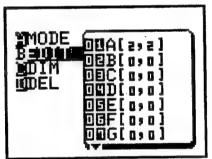
1 ENTER 2 ENTER 3 ENTER 4 ENTER QUIT

MATH E 6 MAT A ENTER (2ndF is not required)

Result: -2.

Editing a matrix

After entering matrix mode, press MENU B and the following menu appears:



To edit a matrix, enter its two digit number, or use the cursor keys to select a matrix and press ENTER. The first column of the matrix appears. Use the cursor keys to position the cursor on a matrix element, enter a new number, variable, or equation and press ENTER.

Example:

Change Matrix A $\begin{bmatrix} 1 & 3 \\ 2 & 4 \end{bmatrix}$ to $\begin{bmatrix} 11 & 3 \\ 2 & 4 \end{bmatrix}$

Press:

MENU B 0 1

Press:

11 ENTER

Result:

A[1,1]=

A[2,1]=

11.

Press:

Result:

A[1,2]=

A[2,2]=

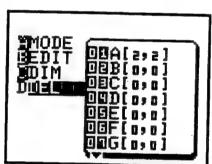
3. 4.

Press:

QUIT

Deleting a matrix

After entering matrix mode, press MENU D and the following menu appears:



To delete a matrix, enter its number, or select it with the cursor keys and press **ENTER**.

Example:

Delete matrix B

Press:

MENU D 0 2

ENTER to del

ENTER to delete the matrix, press QUIT to exit.

Result:

If you pressed ENTER, the matrix was deleted.

Matrix function keys

Except for [], $[X/\theta/T]$ and [Z], all of the keyboard function keys are available in matrix mode.

[MAT] is the matrix identifier function. This function key tells the calculator that a matrix is being referenced. After pressing [MAT], you do not need to press [ALPHA] to select the matrix index. Use the matrix identifier to specify matrices used in calculations.

Example: Calculate Matrix A:
$$\begin{vmatrix} 11 & 3 \\ 2 & 4 \end{vmatrix}$$
 + Matrix B: $\begin{vmatrix} 1 & 16 \\ 31 & 41 \end{vmatrix}$

(First, create the above matrices using the steps described earlier.)

Press: MAT A + MAT B ENTER

Result: ANSI 1, 1]= 12. ANSI 2, 1]= 33.

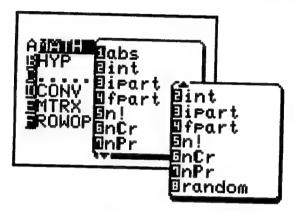
Press: ANSI 1, 2]= 19. ANSI 2, 2]= 19. ANSI

Matrix 27 (ANS) is reserved for matrix operation results. Press QUIT to exit the ANS (or any other) matrix.

Two of the function keys (x^{-1}) and x^{2}) perform operations that are very different from their operation in other modes. x^{-1} calculates the inverse of a square matrix. x^{2} calculates the square of a square matrix. Matrix A divided by Matrix B is the same as Matrix A x Matrix B-1.

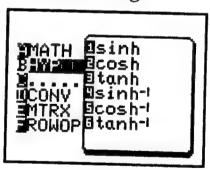
Matrix math functions

Matrix mode has many of the same math functions as real mode. To access the menu functions press MATH. The following math functions are available:



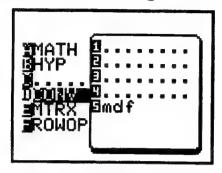
These are the same functions described in the section called "Absolute values, integers, factorials, combinations, permutations, and random numbers." You can use these functions while entering matrix elements, or while performing matrix operations (for example, A[1,2]=25!, or abs det mat A).

Pressing MATH B displays the following:



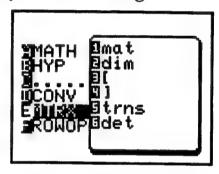
This menu lets you use hyperbolic trigonometric functions. To see some examples of their use, see the section called "Hyperbolic sines, cosines, and tangents."

Pressing MATH D displays the following:



Emdf is the same modify function explained earlier in this chapter.

Pressing MATH E displays the following:



I mat is the matrix specifier. This function is also available on the keyboard.

(盟) Using the Calculator

Edim is the dimension function. This function lets you define a matrix without using MENU. Use this function to define a matrix while programming.

Example:

Define matrix H to be a 4 by 5 matrix.

Press:

MATHE 2 H MATH E 3 4 ALPHA, 5

MATH E 4 ENTER

You can now enter values for all of the matrix elements, or press QUIT and enter them later.

■ I and ■ I are open and close brackets. Use them to reference individual matrix elements, and when using the dim function.

Example:

What is the value of A[1,2]?

Press:

ALPHA A MATH E 3 1ALPHA , 2 MATH 4 ENTER

Result:

3

Do not use the matrix key when viewing individual matrix elements.

Note: You can view all values of a matrix by pressing MAT matrix letter ENTER.

 \blacksquare trns is the transpose function. This function flips an $m \times n$ matrix along its main diagonal, creating an $n \times m$ matrix. The first row of the original matrix is the first column of the transposed matrix, the second row of the original matrix is the second column of the transposed matrix, and so on.

Example: Calculate the transpose of Matrix B: 31 41 55 97

(First, create Matrix B.)

Press:

MATH E 5 MAT B ENTER

Result:

ANS[1,1]=
ANS[2,1]=

Press:

Result:

ANS[1,2]=
ANS[2,2]=
31.

ANS[1,3]=
ANS[2,3]=
55.

Press: QUIT

det is the determinant function. This function calculates the determinant of a *square* matrix.

Example: Calculate the determinant of Matrix C: $\begin{bmatrix} 1 & 2 & 3 \\ 0 & 5 & 6 \\ 0 & 0 & 9 \end{bmatrix}$

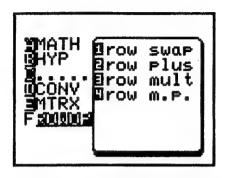
(First, enter Matrix C.)

Press: MATH E 6 MAT C ENTER

Result: 45.

Note: The matrix must be square (number of rows equals the number of columns).

Pressing MATH F displays the following:



I row swap switches any two rows of a matrix. The syntax is: row swap(matrix letter, row1, row2).

Example:	Swap the first and	d second rows of matrix C: $\begin{vmatrix} 1 & 2 & 3 \\ 0 & 5 & 6 \\ 0 & 0 & 9 \end{vmatrix}$
Press:	MATH F 1 (ALF	PHA CALPHA, 1 ALPHA, 2 () ENTER
Result:	ANS[1,1]= ANS[2,1]= ANS[3,1]=	0. 1. 0.
Result: Press:	ANS[1,2]= ANS[2,2]= ANS[3,2]=	5. 2. 0.
Result:	ANS[1,3]= ANS[2,3]= ANS[3,3]=	6. 3.

9.

Press:

QUIT

11221

Erow plus adds any two rows together and stores the result in the second row specified. The syntax is row plus(matrix letter, row1, row2).

	Add the first and second rows of matrix C:	1	2	3	
Example:	Add the first and second rows of matrix C:	0	5	6	l
		0	0	9	

		·
Press:	MATH F 2 (ALPHA CALPHA , 1 ALPHA , 2
Result:	ANS[1,1]= ANS[2,1]= ANS[3,1]=	1.
Press: Result:	ANS[1,2]=	0.
Press:	ANS[2,2]= ANS[3,2]=	2. 7. 0.
Result:	ANS[1,3]= ANS[2,3]= ANS[3,3]=	3. 9. 9.
Press:	QUIT	~•

图图 Using the Calculator

Erow mult multiplies a row by a scalar. The syntax is row mult(scalar, matrix letter, row).

Example:	Multiply 4 times the first row of matrix C: 1 2 3 0 5 6 0 0 9
Press: Result:	MATH F 3 4 ALPHA, ALPHA CALPHA, 1 () ENTER
	ANS[1,1]= ANS[2,1]= ANS[3,1]= 0.
Press: Result:	ANS[1,2]= ANS[2,2]= ANS[3,2]= 5.
Press: Result:	▶
Press:	ANS[1,3]= ANS[2,3]= ANS[3,3]= [QUIT] 12. 6. 9.

and

Frow m.p. multiplies a row by a scalar, adds the row to a second row and stores the result in the second row specified. The syntax is row m.p.(scalar, matrix letter, row1, row2).

	1122
Example:	Multiply 2 times the first row of matrix C: $\begin{bmatrix} 1 & 2 & 3 \\ 0 & 5 & 6 \\ 0 & 0 & 9 \end{bmatrix}$
	add the result to the second row.
Press:	MATH F 4 2 ALPHA , ALPHA CALPHA , 1 (ALPHA , 2) ENTER
Result:	ANS[1:1]= ANS[2:1]= 2.
Press: Result:	ANS[3,1]= 0.
	ANS[1,2]= ANS[2,2]= ANS[3,2]= 9.
Press: Result:	▶
	ANS[1,3]= ANS[2,3]= ANS[3,3]= 12. 9.
Press:	QUIT

Note: You can store the result of a matrix calculation into another matrix by pressing STO MAT letter instead of pressing ENTER.

Data entered in statistics mode can be stored in, or retrieved from, a matrix; for more information, see Chapter 6.

Complex mode

Complex mode lets you perform calculations with complex numbers.

While in calculation mode, press MENU A. Enter complex mode by pressing 4, or use the cursor keys and press [ENTER].

Complex numbers can be written in two forms: $a\pm bi$, or $r\angle\theta$. In rectangular coordinate form (a±bi), a is the real part and bi is the imaginary part. In polar coordinate form $(r\angle\theta)$, $r=\sqrt{a^2+b^2}$ (the distance from the origin), and θ is the angle.

Note: Complex numbers have only 8-digit mantissas in scientific notation.

Use SET UP to set polar or rectangular complex coordinates. See "Complex coordinates" for more information.

Except for [MAT], all of the keyboard function keys of the EL-9300 can be used in complex mode.

In complex mode, the EL-9200 has only basic arithmetic operations available $(+, -, x, \div)$.

Example:

 $(3+2i) \times (3-4i)$

Press:

() 3 + 2 2ndF i () X () 3 - 4 2ndF i () ENTER

Result:

17.-6.i

In complex mode all trigonometric functions use radians regardless of the angular units selected. The selected angular units affect only the complex numbers written in polar coordinates form $(r\angle\theta)$.

Example:

 $(2\angle 30^{\circ})+(3+4i)$

Press:

SET UP B 1 ENTER

() 2 2ndF \(\alpha \) 30()+()3 + 4 2ndF () () ENTER

Result:

4.7320508 + 5.i

Press:

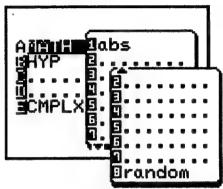
SET UP H 2 ENTER

Result:

6.8842069 \(\alpha 46.577106 \)

Complex functions

To access the math menu functions of complex mode, press MATH and the following menu appears:



Dabs is the absolute value function. The absolute value of a complex number is equal to r in its polar coordinate representation $r \angle \theta$.

Example:

|3+4i|

Press:

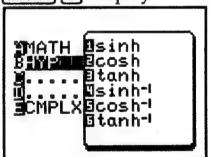
MATH A 1 (3 + 4 2ndF () ENTER

Result:

5.

In random is described in detail in the section called "Absolute values, integers, factorials, combinations, permutations, and random numbers" earlier in this chapter.

On the EL-9300, pressing MATH B displays the following:



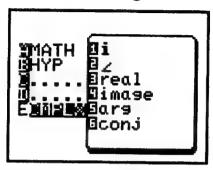
This menu lets you use hyperbolic trigonometric functions. To see some examples of their use, see the section called "Hyperbolic sines, cosines, and tangents." In complex mode all inverse trigonometric functions use radians regardless of the angular units selected.

On the EL-9300, you can use the following functions with complex numbers:

sin, cos, tan, \sin^{-1} , \cos^{-1} , \tan^{-1} , \sinh , \cosh , tanh, \sinh^{-1} , \cosh^{-1} , \tanh^{-1} , \log , \ln , 10^{x} , e^{x} , a^{b} , a^{b} , $\sqrt{\ }$, $\sqrt{\ }$, x^{-1} , x^{2} , abs

On the EL-9200, you can use the following functions with complex numbers:

 x^{-1} , x^2 , abs Sharp EL-9200 and EL-9300 Owner's Manual Pressing MATH E displays the following:



☐ i is the imaginary number equal to the square root of -1. This function is also available on the keyboard (2ndF).

 $\square \angle$ is the polar coordinate separator. This function is also available on the keyboard (\square ndF \square).

Ereal returns the real portion of a complex number.

Example:

What is the real portion of 12+3i?

Press:

MATH E 3 (12 + 3 2ndF) ENTER

Result:

12.

I image returns the imaginary portion of a complex number.

Example:

What is the imaginary portion of 12+3i?

Press:

MATH E 4 (12 + 3 2ndF) ENTER

Result:

3.

Ears returns the argument of a given complex number (equal to $\tan^{-1}(b/a)$). The argument is the angle θ when representing a complex number as $r \angle \theta$.

Example:

What is the argument of 2+2i?

Press:

SET UP B 1 ENTER MATH E 5 (2 + 2 2ndF

() (ENTER)

Result:

45. (degrees)

Econj returns the complex conjugate of a given complex number. The complex conjugate of a+bi is a-bi.

Example:

What is the complex conjugate of 12+3i?

Press:

SET UP H 1 ENTER MATH E 6 (12 + 3

2ndF i) ENTER

Result:

12.-3.i

CHAPTER 4:

Graphing



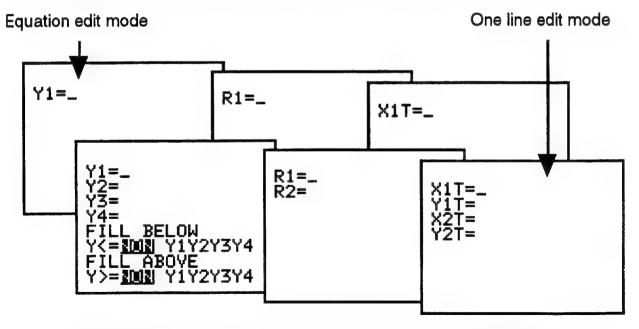
This chapter describes graphing equations in rectangular or polar coordinates, and graphing parametric equations. Tracing and filling functions, defining ranges, plotting points and lines, and zooming are also described.

The general procedure for graphing equations is:

- 1. Enter graph mode.
- 2. Key-in one or more functions.
- 3. Specify the range of the x- and y-axis.
- 4. Press or 2ndF AUTO.

Entering graph mode

Press to enter graph mode. Depending on how you have selected the coordinates in the set up menu, one of the following screens appears:



Rectangular (XY), polar ($R\theta$), and parametric (XYT) screens.

To select coordinates, press SET UP E. For more information, see "Coordinates" near the end of Chapter 2.

Rectangular coordinates

Rectangular coordinate mode is the default graph mode. You can simultaneously graph up to four functions in this mode.

After entering graph mode, use the keyboard and MATH menus to enter a function (an equation or a number) and then press ENTER. The cursor will move to start of the next function.

If there are any previous functions, use CL to clear them.

If you want to move between functions, press \blacktriangledown or \blacktriangle (if you are in equation edit mode, you must press 2ndF \blacktriangledown or 2ndF \blacktriangle). Pressing MENU displays a menu that lets you jump directly to any equation.

Before you graph a function, you must set a range. The easiest way to set the range is to use the auto scaling feature. Press RANGE, enter a minimum, maximum, and scale value for x, and press 2ndF AUTO. For more information, see "Ranges" below.

This example shows some of the powerful graphing features:

Example:

Graph $y=x^4$, and y=x+2.

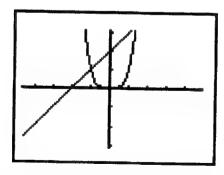
Press:

SET UP E 1 ENTER (set up the calculator)

 $X/\theta/T$ a° 4 ENTER $X/\theta/T$ + 2 ENTER

RANGE MENU ENTER (use the default range)

Result:



You can shade the area between two curves by using the fill functions. Use FILL BELOW to shade an area below a function. Use FILL ABOVE to shade

an area above a function. To select a fill option, simply highlight the option using \blacksquare and \blacktriangleright .

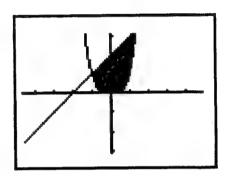
Example:

Now fill in the area that is above x^4 and below x+2.

Press:

MENU 5 ▶ ENTER ▶ Æ

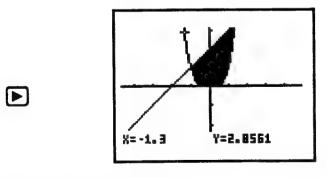
Result:



As shown above, if both FILL BELOW and FILL ABOVE are selected and the curves intersect, only the area between the curves is shaded.

To move along either curve (this is called tracing a curve), press . The x and y coordinates will appear on the bottom of the screen, and a crosshair appears on the graph indicating the current position of the cursor. Use or to move left or right. Use vor to move from one curve to another. If you are tracing Y1 and you press , nothing happens since you are on the first equation. Use and vor attempt to go past the displayed endpoints of a curve. If you attempt to go past the displayed endpoints, the graph will scroll to keep the cursor on the screen.

Here is an example of the trace function:



Press [CL] to clear the coordinates.

Polar coordinates

Polar coordinates graph (r,θ) , where r is the distance from the origin and θ is an angle measured from the positive x-axis. When polar coordinates are selected, pressing $X/\theta/T$ enters a θ in the graph equation screen. You can graph two equations simultaneously.

Example:

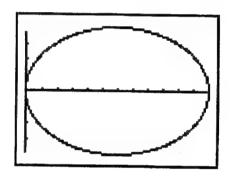
Graph $R=\cos\theta$ using polar coordinates.

Press:

SET UP E 2 B 2 ENTER

COS X/0/T ENTER RANGE 0 ENTER 2ndF π ENTER 2ndF AUTO

Result:



The graph of $r=\cos\theta$ is not a circle because it is distorted. Auto scale sets the length of the x-axis to 1 unit and the length of the y-axis to 1 unit to use as much of the screen as possible. Since the screen is one and a half times wider than it is long, the circle appears elongated. Change the x-range maximum to 1.5 (RANGE) I 1.5 ENTER A) and a circle appears.

Parametric equations

Equations that depend on a third variable to define their points on a plane [x=x(t), y=y(t)] are called parametric equations. The calculator increments t by Tstp to graph each point. When parametric coordinates are selected, pressing $X/\theta/T$ enters a T in the graph equation screen. You can graph two equations simultaneously.

Example:

Graph $x=3\sin T-2$, $y=2\cos T$.

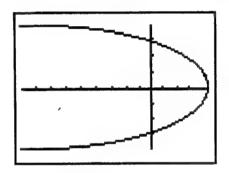
Press:

SET UP E 3 B 2 ENTER 3 Sin X/0/T - 2 ENTER

2 COS X/0/T ENTER RANGE 0 ENTER

2ndF π ENTER 2ndF AUTO

Result:



The angular units selected under DRG of the set up menu affect all equations involving trigonometric functions. Make sure you are using the angular units you want.

Graph function keys

The following is a list of keys that affect graph mode:

KEY

MENU

FUNCTION

7

none

Enters graph mode. If you are

already in graph mode, pressing this key graphs the functions

entered.

EQTN

none

Returns you to equation entry

screen.

KEY

MENU

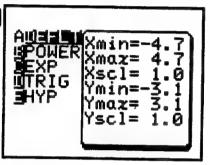
FUNCTION

RANGE

X RANGE	
∰min=	10
Xmaz=	-10.
	10.
Xscl=	
	1.

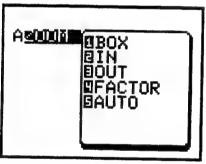
Lets you specify the area of the graph you want see and set the axes' tick-mark annotation.

RANGE MENU



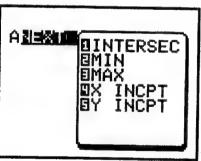
Restores RANGE settings to initial values. Also sets the ranges for functions B to E automatically.

ZOOM



Lets you draw a box to set the range, zoom in or out, and set the zoom factors. This is an easier way to change the viewing window.

2ndF JUMP



Lets you jump to intersection points, minimum and maximum values, and x and y intercepts. These functions are only available in rectangular coordinate mode.

Note: A discontinuous function may be regarded as a continuous function to find intersection points.

2ndF AUTO none

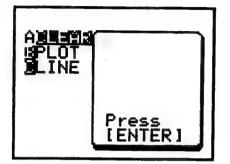
Auto scales the graph. Does not change the θ RANGE or T RANGE. In rectangular coordinate mode it does not change the X RANGE.

KEY

MENU

FUNCTION

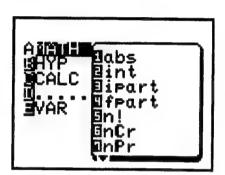
2ndF PLOT



Lets you draw points or lines on the screen.

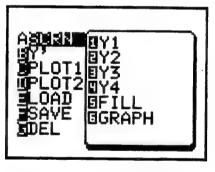
Also clears PLOT.

MATH



Lets you enter math functions to create equations for graphing. Available only while entering equations.

MENU)



Lets you choose specific functions, view the derivative of a function, control graph features, and load, save, and delete graph files.

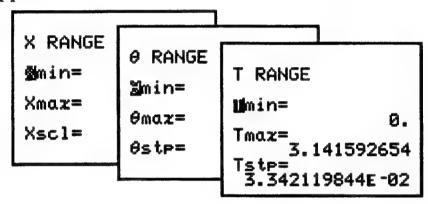
QUIT

none

Exits any menu and returns you to the previous screen. See **EQTN**.

Ranges

You can set the displayed bounds and scale of the axes with RANGE. Changing a range can significantly change a graph's perspective. Set the range so you see the part of the graph you are most interested in viewing. Press RANGE and, depending on the selected coordinate system, one of the following appears:



Rectangular, polar, and parametric range screens.

If rectangular coordinates are selected, the X RANGE screen lets you change the minimum (Xmin) and maximum (Xmax) points of the displayed x-axis. Xscl (x-scale) sets the scale of the tick-marks on the x-axis. You can change any of these settings.

Move to the Y RANGE screen by pressing . The Y RANGE screen displays the minimum (Ymin) and maximum (Ymax) points of the y-axis. Yscl sets the scale of the tick-marks on the y-axis.

The X RANGE and Y RANGE screens are common to all graph modes.

If polar coordinates are selected (SET UP E 2), θ RANGE displays the minimum and maximum values for θ . θ s tp selects the θ step factor (how much θ changes before the next point is plotted). Press \triangleright to move to the x and y range screens. When tracing functions, θ changes by θ s tp with each press of \triangleleft or \triangleright .

If you set the θ range, you can press 2ndF AUTO and the x and y ranges will be scaled automatically. The θ RANGE remains in effect even if you redefine the functions being drawn. θ s to changes in relation to the minimum and

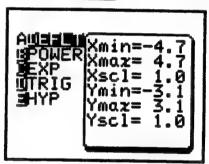
maximum values of θ . If you enter θ s tp, θ max is recalculated. If you enter θ max, θ s tp is recalculated.

If parametric coordinates are selected (SET UP E 3), T RANGE displays the minimum and maximum values for T. Tstp selects the T step factor (how much T changes before the next point is plotted). Press to move to the x and y range screens. When tracing functions, T changes by Tstp with each press of or .

If you set the T RANGE, you can press 2ndF AUTO and the x and y ranges will be scaled automatically. The T RANGE remains in effect even if you redefine the functions being drawn. Tstp changes in relation to the minimum and maximum values of T.6 If you enter Tstp, Tmax is recalculated. If you enter Tmax, Tstp is recalculated.

The range menu

While in the range screen, press MENU and the following appears:



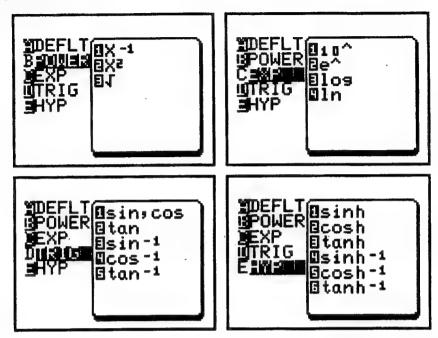
This menu lets you select predefined ranges that are appropriate for common functions graphed in rectangular coordinates. To select the default press **ENTER**.

 $[\]frac{\theta_{\text{max}} - \theta_{\text{min}}}{\theta_{\text{stp}}} = 90 \text{ (maximum number of points drawn per polar screen)}$

⁶ Tmax-Tmin = 94 (maximum number of points drawn per parametric screen)



The other menus are:



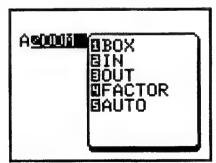
In general, select the predefined range that resembles your function. For example, if your function is $y=\log x/3$, select C 3 (109).

The trigonometric ranges are automatically adjusted for the angular units selected in the set up menu (Deg, Rad, or Grad).

Zooming

The zoom feature lets you change the range of the graph without entering specific numbers for each coordinate.

Press **ZOOM** and the following menu is displayed:



B BOX lets you draw a box around an area of interest. The boxed area then fills the entire screen, distorting the graph as necessary. After BOX is

selected move the cursor to a starting point for the box and press ENTER. Move the cursor diagonally to draw a box and press ENTER.

IN zooms in on the graph by an amount determined by FACTOR. If you use the trace feature to select a point on the curve (before you zoom in), that point becomes the screen center.

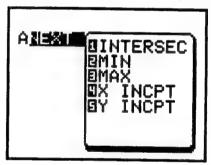
E OUT zooms out on the graph by an amount determined by FACTOR. If you use the trace feature to select a point on the curve (before you zoom out), that point becomes the screen center.

■ FACTOR lets you set the zoom factor (the number that the range is divided by when zooming in, or multiplied by when zooming out). The x-factor can differ from the y-factor.

EAUTO performs the same function as pressing [2ndF] [AUTO]. (see page 86)

Jump

The jump function jumps to the next (from left to right) point of interest on the screen. Press [2ndF] JUMP and the following menu appears:



INTERSEC jumps to the next intersection of any two functions and displays the coordinates on the screen. The calculator may not be able to find the intersection if multiple roots exist.

EMIN jumps to a function's next minimum value (moving left to right). Since the calculator estimates the minimum, answers are approximate.

EMAX jumps to a function's next maximum value (moving left to right). Since the calculator estimates the maximum, answers are approximate.

IX INCPT jumps to where a function crosses the x-axis.

EY INCPT jumps to where a function crosses the y-axis.

Graphing

It may appear as if the cursor is not exactly at a point of intersection. This is due to the graph resolution. The displayed value and cursor position are correct.

Auto

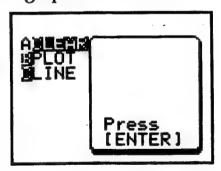
The auto scale function, automatically scales the range of the y-axis when using rectangular coordinates. The auto scale function looks at the x range, computes the maximum and minimum values for y in that range, and then sets an appropriate y range. If you get unexpected results from this function, check the new y range settings.

When graphing in polar coordinates, 2ndF AUTO sets the x and y range based upon the θ min and θ max values.

When graphing parametric equations, [2ndF] AUTO sets the x and y range based upon the Tmin and Tmax values.

The plot menu

Press 2ndF PLOT while in graph mode and the following menu appears:



ICLEAR clears the entire graph area when you press **ENTER**.

ISPLOT lets you draw dots on the screen. PLOT has two options, DIRECT and FREE.

■ DIRECT prompts you for an x and y coordinate and draws a single point.

EFREE lets you use the cursor keys to move around the screen and draw a dot whenever ENTER is pressed. The cursor's coordinates are displayed at the bottom of the screen.

LINE lets you draw lines on the screen. LINE also has two options, DIRECT and FREE.

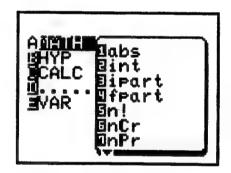
DIRECT prompts you for two x and y coordinates and draws a single line that connects them.

EFREE lets you use the cursor keys to move around the screen and draw line segments. Press ENTER to select the starting point, move to the ending point and press ENTER again to draw the line. You can continue to draw connected lines by moving to a new location and pressing ENTER.

Plot functions remain on the screen until a graph is redrawn or CLEAR is selected.

The math menu

The MATH menu provides many of the math functions presented in calculation mode:

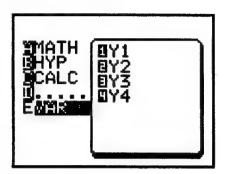


MATH and MHYP are functions described in Chapter 3.

ECALC has only one option: d/dx(, unlike calculation mode, you do not need to enter an x-value or Δx -value. The derivative will be automatically calculated at the various x-values. Therefore, the syntax is simply d/dx(function). For example, $Y1=x^2$, Y2=d/dx(Y1) are valid functions.

Note: On the EL-9200, d/dx cannot be used in graph functions or graph programs.

■VAR has the following four options:

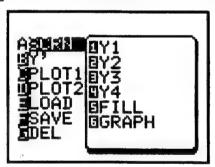


These options let you use graph functions within a function. For example, you can define $Y1=\sin(x+5)-\cos(x)$, and $Y2=\operatorname{ipart}(Y1)$.

You cannot have self-referencing functions (for example, Y4=Y4+1 is not a valid function).

The graph menu

Press MENU while in graph (XY) mode and the following menu appears:



#SCRN lets you quickly jump to a desired equation or one of the fill functions. Y1 puts the cursor on equation Y1, Y2 puts the cursor on equation Y2, and so on. GRAPH, like ∰, graphs the defined functions.

If Y' turns the trace derivative function on or off. If Y' is set to ON the value of the derivative of the function at the current x appears on the screen with the x and y coordinates when tracing. Y' is only available when coordinates are set to rectangular (XY).

MPLOT1 selects whether points are connected (Connect) or discrete dots (Dot).

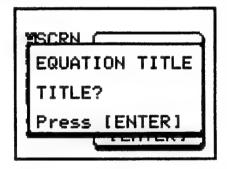
UPLOT2 selects whether the functions should be drawn one after the other (Sequence) or all at the same time (Simul).

<u>BLOAD</u> recalls stored graph files. (Select file from sub menu displayed) Loading a stored function clears the current equation. The following warning message appears:



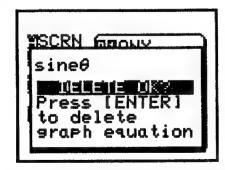
Press QUIT to exit without loading.

■SAVE saves the current graph setup and functions as a file. Files include all range, screen, and function information. When you press MENU [F] [ENTER], the following menu appears:



The calculator is in alpha lock mode. Enter a file name (up to 14 characters) and press ALPHA ENTER to save the file. You can save up to 99 (10 for EL-9200) equations.

DDEL deletes a file. (Files are displayed as in LOAD mode). Press G, select the file you want to delete, and press **ENTER**. A warning message similar to the following appears:



Press ENTER to confirm the deletion, or press QUIT to cancel.

CHAPTER 5:

Programming

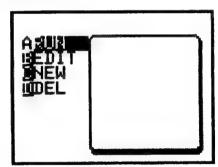


You can program your calculator to automate simple or complex calculations. Each program can use one of five modes: REAL, NBASE, MATRIX, COMPLEX, or STAT. Programs in REAL mode can draw graphs and access statistical variables. Programs in NBASE mode can perform logical operations and do calculations using hexadecimal, decimal, octal, or binary numbers. Programs in MATRIX mode have matrix functions enabled and programs in COMPLEX mode have complex functions enabled. Programs in STAT mode can use the statistic functions and draw statistical graphs.

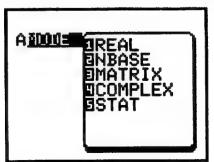
Creating a new program

Follow this general procedure to create a new program:

1. Press to bring up the program menu. Any existing programs appear on the right side of the screen.



2. Press C ENTER and select the mode you want the program to run in.



Programming Programming

- 3. Name the program and press [ALPHA] [ENTER].
- 4. Enter program commands. You can enter the calculator's regular functions as commands plus additional programming commands found under [2ndF] [COMMAND]. The commands available in this menu depend on the mode.

For examples of several programs, see the section titled "Example Programs."

About programming

This manual does not cover all of the concepts behind writing programs. The information here is intended to help you apply your previous programming experience (in BASIC, FORTRAN, or another language) to writing programs on your calculator. The calculator programming language has similar elements to many programming languages.

All computer and calculator programs include one or more of the following fundamental elements:

- Input
- Conditional branching
- Looping
- Computation
- Output

Your calculator has programming commands that allow you to incorporate all of these fundamental elements into your programs. For a list of commands, see the section called "Programming commands."

Notes: Commands must be selected with shift command, not typed in manually with alpha mode.

Only one space should be used between commands and variables.

Although there are many commands, it is possible to program the calculator without using any of the program commands.

Example:

Write a program that asks you the base and height of a

triangle and then calculates and prints the area.

Press:

© ENTER 1

(The calculator automatically enters alpha mode for

you to enter the title.)

Press:

tri ALPHA ENTER

2ndF A-LOCK area = ALPHA (1 ÷ 2) 2ndF

A-LOCK base ALPHA x 2ndF A-LOCK

height ALPHA ENTER

Now run the program:

Press:

MENU A

Select the program called "tri" with the cursor keys and press ENTER.

base=?

Press:

4 ENTER

height=?

Press:

4 ENTER

Result:

area= 8.

Press:

CL or QUIT to end, or press ENTER to begin the

program again.

As shown above, the calculator automatically prompts you for unknown local variables. For more information, see the section below called "About variables."

Typing and editing programs

It takes just a little practice to become proficient at typing programs on your calculator. Here are a few reminders and suggestions to help you speed up program entry:

- Whenever you want to add lines to your program, press 2ndF INS first to avoid deleting lines or text you want to keep.
- As you learned in Chapter 1, the ALPHA key lets you use the alpha functions on the calculator. Use 2ndF A·LOCK to lock the calculator in

Programming

- alpha mode when you want to enter long strings of characters into your programs. Press ALPHA to turn off the lock.
- In alpha mode, pressing one of the keys with a letter enters a lowercase character. Press 2ndF to get uppercase characters. Read the section "About variables" below to learn the difference between using lowercase and uppercase characters in your programs. There is no way to lock the calculator into uppercase only.
- Except for certain special cases, you can only have one command per line.
- A programming line can hold 160 (128 for EL-9200) characters. All commands count as one character. As you work on a line, it scrolls from left to right in the display. Programming lines do not wrap in the display.
- When running a program, text displayed by the program (using the Print command) will wrap in the display if necessary.
- The line you are working on does not change in the program until you press or ENTER. This feature allows you to quickly undo changes you make to a program line by pressing QUIT ENTER ENTER. However, if you want to save changes you made to the current line, don't forget to press before quitting.
- Blank lines entered between lines of a program are ignored.
- To clear an entire line of the program, press CL. You should quickly learn the difference between the CL key and the BS key. BS is useful for correcting typing mistakes.
- To delete an entire program, press 2ndF CA.
- Copy or move a program with the option menu, see Chapter 2 for more details.
- Change the name of a program by using the cursor keys and ALPHA.

About variables

In program mode, the case of your variables makes a difference:

- Single uppercase letters (A to Z and θ) are global variables. Global variables correspond to the memories of the calculator. (For example, C in a program means memory C of the calculator.) Global variables allow your programs to use values stored in memories, or to pass variables from one program to another. Global variables also allow you to store results from programs to use in any mode.
- Lowercase letters, lowercase numbers (2ndF number), and lowercase words are local variables. (For example, you may choose to use c in a program as a local variable.) Local variables exist only while the program exists. Local variables can be 12 letters or less.
- Uppercase and lowercase letters cannot be mixed to form one variable. The single uppercase letters will always be taken as a single variable.

Here's some examples of how you may use variables in a program:

- 1. X = 5: This program line sets the program variable X equal to 5. It also stores 5 in the X memory.
- 2. heat = 9.22: This program line sets the program variable "heat" equal to 9.22. When the program ends, this variable will be stored in local variables.
- 3. Y = mX+b: sets Y equal to (m * X) + b. If m and b are not defined earlier in the program, the calculator prompts you with m=? and b=? to define these two variables. The program takes the value for X from its own X memory.

Turn the above equation (Y = mX + b) into a program.

Example:

Program the equation Y = mX + b.

Press:

4.4 STO X C ENTER 1

slope ALPHA ENTER

2ndF A·LOCK 2ndF Y = m 2ndF X ALPHA + ALPHA

b 🔻

Programming

Now run the program:

Press:

QUIT A

Select the program named "slope"

ENTER

m=?

Press:

5 ENTER

b=?

Press:

7 ENTER

Y = 29.

The answer depends on what you have stored in the X memory. The calculator prompts you for the lowercase letters m and b, but not for X.

The previous example shows you two ways your programs can receive input. Using an undefined local variable in a program causes it to ask for input. Using a global variable causes the program to take input from memory. Another way programs can receive input is to use the Input command listed below.

Programming commands

This section describes all the available commands in program mode. The commands are listed alphabetically. The list does not include available keyboard commands or MATH menu commands.

Unless otherwise noted, the programming commands are available in all program modes.

Auto < graph command>

2ndF COMMAND D2

(available in REAL and STAT programs only)

Selects a Y range and then performs the graph command. The graph command can be Graph, DotGraph, Fill, or any of the statistical graph commands.

Examples:

Auto Graph sin X, cos X, tan X

Auto G(HIST)

ClrG

2ndF COMMAND E2

Clears the Graph Screen, without affecting any text or changing display modes.

Example:

ClrG

ClrT

2ndF COMMAND E1

Clears the Text Screen, without affecting any drawn graphs or changing display modes.

Example:

ClrT

Data $< x > \{,y\} \{,w\}$

2ndF COMMAND F5

(available in STAT programs only)

Enters a new statistical data point in the next available card. The arguments must be consistent with the statistics mode selected (one-variable or two-variable, weighted or not weighted). The statistical data set can be accessed later in statistics mode.

Examples:

Data 5.23

Data 25,2 Data 72,175 Data 9,96,3

DispG

2ndF COMMAND E4

Shows the Graph screen.

Example:

DispG

DispT

2ndF COMMAND E3

Shows the Text Screen.

Example:

DispT

DotGraph < func1> {,func2} {,func3} {,func4}

2ndF COMMAND D3

(available in REAL programs only)

Same as the Graph command except that it draws non-connected dot graphs. (This command does not change the setting in graph mode.)

Example:

DotGraph sin X, cos X, tan X

Programming

End

2ndF COMMAND A6

Marks the end of a program. End is not required to end a program. If there is no end statement, the calculator will display the last calculated answer upon completion of the program. End does not need to be at the end of a program, and there can be more than one end command in a program (for example, to end different subroutines).

Example:

End

Fill <func1> <,func2>

2ndF COMMAND D8

(available in REAL programs only)

Draws a graph and fills the space (if any) below function 1 and above function 2.

Example:

Fill sin X, cos X

G(B.C.)

2ndF COMMAND G6

(available in STAT programs only)

Draws a box chart from the current statistical data. Statistics mode must be XY or XYW. The maximum number of boxes that can be displayed is 11.

Example:

G(B.C.)

G(B.L.)

2ndF COMMAND G2

(available in STAT programs only)

Draws a broken line chart from the current statistical data. The maximum number of data points that can be displayed is 31.

Example:

G(B.L.)

G(C.F.)

2ndF COMMAND G3

(available in STAT programs only)

Draws a cumulative frequency chart from the current statistical data. The maximum number of data points that can be displayed is 31.

Example:

G(C.F.)

G(exp)

2ndF COMMAND H2

(available in STAT programs only)

Draws the best fit exponential regression curve from the current statistical data. Statistics mode must be XY or XYW.

Example:

G(exp)

G(HIST)

[2ndF] [COMMAND] G1

(available in STAT programs only)

Draws a histogram from the current statistical data. The maximum number of data points that can be displayed is 31.

Example:

G(HIST)

G(inv)

2ndF COMMAND H6

(available in STAT programs only)

Draws the best fit inverse regression curve from the current statistical data. Statistics mode must be XY or XYW.

Example:

G(inv)

G(line)

2ndF COMMAND H1

(available in STAT programs only)

Draws the best fit linear regression line from the current statistical data. Statistics mode must be XY or XYW.

Example:

G(line)

G(ln)

2ndF COMMAND H3

(available in STAT programs only)

Draws the best fit natural logarithmic regression curve from the current statistical data. Statistics mode must be XY or XYW.

Example:

G(ln)

G(log)

2ndF COMMAND H4

(available in STAT programs only)

Draws the best fit logarithmic regression curve from the current statistical data. Statistics mode must be XY or XYW.

Example:

G(log)

Programming

G(N.D.)

(available in STAT programs only)

2ndF COMMAND G4

Draws a normal distribution curve from the current statistical data.

Example:

G(N.D.)

G(pow)

2ndF COMMAND H5

(available in STAT programs only)

Draws the best fit power regression curve from the current statistical data. Statistics mode must be XY or XYW.

Example:

G(pow)

G(S.D.)

2ndF COMMAND G5

(available in STAT programs only)

Draws a scatter diagram from the current statistical data. Statistics mode must be XY or XYW.

Example:

G(S.D.)

Gosub <anytext>

2ndF COMMAND B4

Calls the subroutine beginning with Label *<anytext>*. A Gosub statement must have a matching Label to mark the beginning of the subroutine, and a Return command to mark the end of the subroutine. Subroutines can be nested up to ten levels deep.

Example:

Gosub part1

Goto <anytext>

2ndF COMMAND B2

Jumps program execution to Label <anytext>.

Example:

Goto loop

Graph < func1> {,func2} {,func3} {,func4}

2ndF COMMAND D1

(available in REAL programs only)

Graphs up to four functions. Commas must be used to separate the functions. The graphs are drawn sequentially or simultaneously according to the setting in Graph mode.

Examples:

Graph sin X, cos X, tan X

Graph $3X^2-2X+6$

If <conditional expression> Goto <anytext>

2ndF COMMAND B3

2ndF COMMAND B2

Conditional branches begin with an If command (B3), followed by a conditional expression, and then a Goto command (B2). Goto is the only command that can follow an If statement. You can place a space (ALPHA SPACE) before the Goto command to improve the readability.

Example:

If apple=1 Goto loop

Inequalities

2ndF COMMAND C1 to C6

Forms the conditional expressions used with If and Goto. The inequalities are the basis for looping and conditional branching in your programs. The inequalities are:

2ndF COMMAND C 1 = Equal to (Same as

(ALPHA =)

2ndF COMMAND C 2 < Less than

2ndF COMMAND C3 <= Less than or equal to

2ndF COMMAND C4 >= Greater than or equal to

[2ndF] [COMMAND] C 5 > Greater than

2ndF COMMAND C 6 \neq Not equal to

Examples:

If X<0 Goto neg

If z=3 Goto ratecalc

In the above examples, "neg" and "ratecalc" are labels.

Input <variable>

2ndF COMMAND A3

Stops the program and prompts you with "<variable>=?" to enter a value for <variable>.

Examples:

Input A

Input apple Input A[1,1]

In the above examples, A is a global variable and apple is a local variable. A[1,1] is a matrix element.

Programming

Label <anytext>

2ndF COMMAND B1

Marks a destination point for a branch statement (such as Goto). Each label must be unique (you can't enter the same label more than once in the same program) and must be ten (eight for EL-9200) characters or less. The label can be used 50 pcs. or less (12 pcs. or less for EL-9200) in each program.

Example:

Label loop

Line $\langle x_1 \rangle$, $\langle y_1 \rangle$, $\langle x_2 \rangle$, $\langle y_2 \rangle$

2ndF) [COMMAND] D7

(REAL and STAT programs only)

Draws a line between points x_1, y_1 and x_2, y_2 .

Example:

Line 180,1,-180,1

Plot <x>, <y>

2ndF COMMAND D6

(available in REAL and STAT programs only)

Plots a point at coordinates x,y.

Example:

Plot 180,1

Example:

Print "Hello world

Print <variable>

2ndF COMMAND A1

Prints the value of <variable>. The display format is determined by the SET UP menu.

Examples:

Print A

Print apple Print A[1,1]

In the above examples, A is the value currently stored in memory A, and apple is a local variable. A[1,1] is a matrix element.

Range <xmin>, <xmax>, <xscale>, <ymin>, <ymax>, <yscale> {,n} 2ndF COMMAND D4 (available in REAL and STAT programs only) Sets the range for the graphing screen. The y range is required even if the Auto Graph function is used to plot the curve. The n value is the number of segments for statistical graphs.

Example:

Range -360,360,90,-1.2,1.2,0.5

Rem <any text>

2ndF COMMAND A5 Inserts a remark statement. This line has no effect on the program operation. It allows you to document your programs. Excessive use of this command will use up extra memory.

Example:

Rem Temperature-Pressure conversion

Return

2ndF COMMAND B5

Ends a subroutine and resumes program operation at the line following the Gosub statement that called the subroutine.

Example:

Return

St[<1, 2, or 3>, < n>]

[2ndF] [COMMAND] F6

(available in STAT programs only)

Recalls or stores a value in an existing statistics card. The first variable specifies x, y, or w, and the second variable specifies the data card number. The square parentheses are required in the syntax (2ndF) [COMMAND] F7 and [2ndF] [COMMAND] F8) and are available from the same command menu. Use this statement consistently with the statistics mode selected (one-variable or two-variable, weighted or not weighted), or you will get an error.

one-variable 1 is the x-value

one variable with weight 1 is the x-value

2 is the weight

two variable 1 is the x-value

2 is the y-value

two variables with weight 1 is the x-value

> 2 is the y-value 3 is the weight

Examples:

St [1,234]

St [3,14]=3

The first example recalls the x-value of card 234. The second example sets the weight of card 14 to 3.

Stat X

2ndF COMMAND F1

(available in STAT programs only)

Selects one-variable statistics mode.

This command erases all of the data stored on the statistics cards. Note:

Example:

Stat X

Stat XW

[2ndF] [COMMAND] F2

(available in STAT programs only)

Selects weighted one-variable statistics mode.

Note: This command erases all of the data stored on the statistics cards.

Example:

Stat XW

Stat XY

2ndF COMMAND F3

(available in STAT programs only)
Selects two-variable statistics mode.

Note: This command erases all of the data stored on the statistics cards.

Example:

Stat XY

Stat XYW

2ndF COMMAND F4

(available in STAT programs only)

Selects weighted two-variable statistics mode.

Note: This command erases all of the data stored on the statistics cards.

Example:

Stat XYW

Wait {number}

2ndF COMMAND A4

Pauses the program for *{number}* seconds or until you press a key. The maximum number of seconds is 255. If you don't specify a wait time, then the program pauses until you press a key. The BUSY indicator stays on while the program is waiting. Wait is useful for displaying intermediate results and other information.

Example:

Wait 5

Zoom $\langle n \rangle \{,yn\}$

2ndF COMMAND D5

(available in REAL and STAT programs only)

Zoom adjusts the range by a factor of 1/n. If two values are used, then the first value adjusts the X range, and the second value adjusts the Y range. The scale settings are not adjusted by the zoom command. You must draw a graph before you zoom.

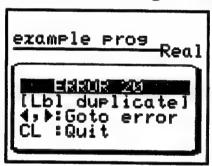
Examples:

Zoom 2

Zoom 1,5

Error Messages

After entering a program, it's often necessary to debug it. To make this task easier, the calculator displays an error message if it has a problem running your program. For example, if you have more than one label with the same name in your program, you see the following message:



To see the faulty line, press or ▶. To return to the program menu, press CL.

At any time while running your program you can press ON to stop it. This would be necessary if your program has entered an endless looping sequence. Then press or ; the cursor appears at the last line your program executed.

For a list of error messages, see Appendix B.

Example programs

Try running these examples to get some experience programming the calculator. They demonstrate different programming modes, program input, program output, looping, and conditional branching.

Some like it hot (Real mode)

Suppose you need to convert temperatures from Celsius to Fahrenheit and vice versa. You could do this using calculation mode or using the EL-9300's solver mode. A third way would be to create a program as follows:

- 1. Press to select program mode. Press C ENTER 1 to create a new REAL mode program.
- 2. Name the program temp conv and press ALPHA ENTER.
- 3. Enter the following program lines:

```
Label start
Print "1 C to F
Print "2 F to C
Input choice
If choice=1 Goto ctof
If choice=2 Goto ftoc
Goto start
Label ctof
Input c
f=(9/5)*c+32
Print f
End
Label ftoc
Input f
c=(5/9)*(f-32)
Print c
End
```

4. Now try running the program. Press QUIT, A, select the program, and press ENTER. The program prompts you to choose the type of conversion you want, prompts you to enter the temperature, and displays the results.

2B OR NOT 2B (Nbase mode)

When you write a program in Nbase mode, the conversion functions and logical operations are enabled. Write a simple program that converts a decimal number to binary, octal, and hexadecimal as follows:

- Press C ENTER 2 to create a new NBASE mode program.
- 2. Name the program dec conv and press ALPHA ENTER.
- 3. Enter the following program lines:

Print "Enter a decimal

Input X

X⇒bin

(Press MATH D 4 to enter the *bin command.)

binary=X

Print binary

X+oct

octal=X

Print octal

X+hex

hexadecimal=X

Print hexadecimal

Notice that the program transfers the value of X to the variables binary, octal, and hexadecimal before printing. This is done so that the display is labeled properly.

- 4. Now try running the program. Press QUIT, A, select the program, and press ENTER. The program prompts you to enter a decimal and returns the three conversions.
- 5. Note that you will get an error if you try to convert a number larger than 32767 to binary. For more practice, add a conditional branch to your program that skips binary conversion if x>32767.

2 x 4 (Matrix mode)

When you write a program in matrix mode, all of the matrix functions are available. Suppose you wanted to fill a n by m matrix with random numbers between 0 and 1. You would need to use the random number function and two nested loops as shown in the following example.

- 1. Press C ENTER 3 to create a new MATRIX mode program.
- 2. Name the program mut fill and press ALPHA ENTER.
- 3. Enter the following program lines:

```
dim A[n,m] (Press MATH E to find the dim, [, and ]
commands.)
i=1
Label filli
j=1
Label fillj
A[i,j]=random (Press MATH A 8 to enter the random command.)
j=j+1
If j<=m Goto fillj
i=i+1
If i<=n Goto filli
End</pre>
```

- 4. Now try running the program. Press QUIT, A, select the program, and press ENTER.
- 5. To see the filled matrix, press QUIT BE MENU A 3 MENU B 01. Scroll through the matrix and note that all of the entries are numbers between 0 and 1.

Do you have a complex? (Complex mode)

Write a program the asks for a complex number as input, then tells you real portion, the imaginary portion, the argument, and the complex conjugate of the complex number.

- 1. Press C ENTER 4 to create a new COMPLEX mode program.
- 2. Name the program X+Yi and press (ALPHA) (ENTER).
- 3. Enter the following program lines:

```
realp=real number (Press MATH) E to find the complex functions.)
imasin=imase number
arsmt=ars number
conjst=conj number
Print realp
Print imasin
Print arsmt
Print conjst
End
```

- 4. Now try running the program. Press QUIT, A, select the program, and press ENTER.
- 5. The program asks you for a number, and then prints all of the data.

The top ten (STAT mode)

Write a simple program that asks for ten test scores and graphs a histogram of the data, as follows:

- 1. Press C ENTER 5 to create a new STAT mode program.
- 2. Name the program grader and press ALPHA ENTER.
- 3. Enter the following program lines:

```
Gosub inscore
Gosub avascore
Gosub erscore
End
Label inscore
Stat X
Print "Enter scores
i=1
Label iloop
Input X
Data X
i=i+1
If i<=10 Goto iloop
Return
Label avescore
Print "Average score is
           (Press \overline{MATH} \overline{E} 1 to enter the x average, \overline{z}.)
X=Z
Print X
Wait 5
Return
Label srscore
Ranse 0,100,10,0,10,1,10
G(HIST)
Return
```

Programming

When you run the program, the test scores must be between 0 and 100 (if you want to see them all).

Deleting programs

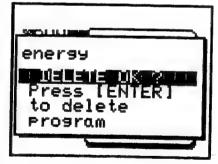
You can have up to 99 (51 for EL-9200) programs. To clear space for new programs, delete the old ones.

Delete a program as follows:

- 1. Press to select program mode.
- 2. Press D to select the delete function.



3. Enter the number of the program you want to delete or select it using the cursor keys and press **ENTER**.



4. The calculator asks if you want to delete the program. Press **ENTER** to delete the program.

Note: A quick way to delete a program while editing is to press 2ndF CA. The above warning message appears. Press ENTER to delete the program.

CHAPTER 6:

Using Statistics

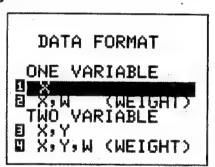


Your calculator can perform one- and two-variable weighted statistics calculations.

Normal calculator functions are also available in statistics mode, and statistical results can be used in calculations or programs.

Selecting statistics mode

To select statistics mode, press [=]. If there isn't any statistics data, the following menu is displayed:



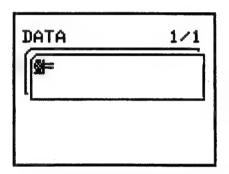
Select one of the four formats: one variable (X), one variable with weight (X,W), two variables (X,Y), and two variables with weight (X,Y,W).

One-variable statistics

Note:

You must delete all statistics data to enter a new statistics data format. See the section below called "Deleting data." If you want to save your data, see "Transferring data to a matrix."

Press [1] to select one-variable statistics, and the first "card" of data appears.



Each card contains one data value (often called an *observation* by statisticians). Use the keypad to enter the data values. After pressing ENTER the calculator displays the next card (the next data value). To display the previous data value, press . To display the next data value press . Use 2ndF or 2ndF be to jump to the first or last card. The card/count number is displayed at the top right of the card. For example, 2/5 means that the second of five cards is currently displayed.

```
Example: What is the mean of the following test scores: 75, 85, 90, 82, and 77?

Press: \boxed{1} 75 ENTER 85 ENTER 90 ENTER 82 ENTER 77

ENTER

Press: \boxed{MENU} A 1

Result: \boxed{x} = 81.8

5x = 6.058052492

\sigma x = 5.418486874

\boxed{\Sigma}x = 409.

\boxed{\Sigma}x^2 = 33603.

\boxed{n} = 5.

\boxed{xmi} = 75.
```

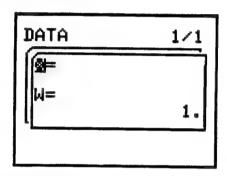
If you don't know what the results mean, see "The statistics menu," below.

xma=

90.

One-variable with weight

If your sample data contains a value that is repeated a number of times, enter it as a weighted variable. For example, entering a variable with a weight of 5 is the same as entering the value five times. Weighted one-variable data cards look like this:



Key-in the x value, press **ENTER**, and enter the weight.

Example: What is the mean of the following test scores: 75, 75, 75, 75, 75, 90, 90, 77.

Press: MENU D 2 ENTER Deletes any

previous data.

Press: Selects one-variable with weight.

75 ENTER 4 ENTER 90 ENTER 2 ENTER 77 ENTER

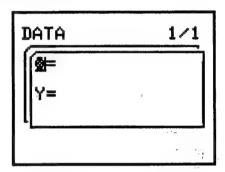
Result: $\bar{z} = 80.$ sz = 7.745966692 $\sigma z = 7.071067812$ $\Sigma z = 480.$ $\Sigma z^2 = 38700$

 $\Sigma x^2 = 38700.$ n = 6. xmi = 75. xma = 90.

If no weight is entered, w is automatically set to 1.

Two-variable statistics

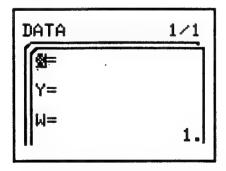
Entering data for two-variable statistics is similar to one-variable statistics, except that data points are identified as a pair (x,y). After selecting , delete any previous data (MENU D 2 ENTER) and press 3. The first card of data appears:



Key-in x, press ENTER, and key-in y. Pressing ENTER automatically moves you to the next card so you can enter the next data pair. Use ◀ and ▶ to move between cards.

Two-variables with weight

If your sample data contains pairs that are repeated a number of times, enter it as weighted two-variable statistics. For example, entering one data pair with a weight of 10 is the same as entering the data pair ten times. After selecting (delete any previous data (MENU D 2 ENTER)) and press 4, the first card of data appears:



Use the keypad to enter the x value, press ENTER, enter the y value, press ENTER, and enter the weight. Use the and keys to move between cards.

```
Find the mean of the following 30 math and physics
Example:
              test scores: 10 at (80,75), 15 at (90,80), 4 at (90,90), and 1
              at (95,90).
Press:
              MENU D 2 ENTER 4
(Deletes any old data and enters two-variables with weight mode.)
              80 ENTER 75 ENTER 10 ENTER 90 ENTER 80 ENTER
Press:
              15 ENTER 90 ENTER 4 ENTER 95 ENTER 90
               ENTER] [ENTER]
               MENU A 1
                                (The math test statistics)
Result:
                 = 86.8333333
              sz = 4.997125611
              σz = 4.913134324
                           2605.
                         226925.
              2mi=
              zma=
Press:
              MENU][2]
                                (The physics test statistics)
Result:
                             80.
              sy = 5.085476277
                         208950.
             yma=
```

If no weight is entered, w is automatically set to 1.

Entering data

When entering statistical data you can enter numbers, variables or equations, but only the result is stored. If you make a mistake while entering data press CL (before you press ENTER) and the previous entry will be returned. 2ndF CA deletes an entire card.

You may enter up to 999 (EL-9200: 199 for single-variable and 99 for two-variable) data cards or observations.

The statistics menu

The MENU key lets you view statistical results, move through the data cards, mask, delete, or sort data, and store or retrieve data in matrices.

Statistical results

After entering the data, view statistical results by pressing MENU A, and the following menu is displayed:



X VARS

11 X VARS shows the x statistics. Assuming you completed the previous example, selecting X VARS displays the following statistical results:

```
\bar{z} = 86.83333333

sx = 4.997125611

\sigma x = 4.913134324

\Sigma x = 2605.

\Sigma x^2 = 226925.

n = 30.

zmi = 80.

zm\alpha = 95.
```

Where:

 $\overline{\mathbf{x}}$ is the average or mean value of the data.

sx is the sample standard deviation. Sample standard deviation assumes the data is a sample from a population.

σz is the population standard deviation.⁸ Population standard deviation assumes that the data represents the entire population.

 Σx is the sum of the x data values.

 Σx^2 is the sum of the squares of the x data values.

n is the number of data values entered (the number of observations or cards).

zmi is the minimum value of x.

zma is the maximum value of x.

YVARS

BY VARS is available only when two-variable data has been entered.

Y VARS shows the y statistics. If you just completed the previous example using two-variable observations, Y VARS displays the following statistical results:

$$\bar{y}$$
 = 80.
 sy = 5.085476277
 σy = 5.2400.
 \bar{y} = 192750.
 \bar{y} = 208950.
 y = 75.
 y = 90.

Where:

is the average or mean value of the y-data values.

$$7_{SX} = \sqrt{\frac{\sum x^2 - n\overline{x}^2}{n-1}}$$
 $Sy = \sqrt{\frac{\sum y^2 - n\overline{y}^2}{n-1}}$
 $8_{OX} = \sqrt{\frac{\sum x^2 - n\overline{x}^2}{n}}$ $OY = \sqrt{\frac{\sum y^2 - n\overline{y}^2}{n}}$

@Using Statistics

is the standard deviation when the y-values constitute a sample chosen from a population⁷.

συ is the standard deviation when the y-values form a population8.

Σy is the sum of the y-data values.

Σy2 is the sum of the squared y-data points.

צאש is the sum of the x-data values multiplied by their corresponding y-data values.

ymi is the minimum value of y.

yma is the maximum value of y.

Regression

EREG shows regression data. This option is available only when two-variable data has been entered. A model for the relationship between an expected value of a variable and the value of a related variable is called a regression. If you select REG from the variable menu, the following linear regression results are displayed:

Where:

 \mathfrak{a} is the first regression coefficient, that is, the y-intercept of the linear regression equation y=a+bx.

b is the slope of the regression line.

r is the correlation coefficient.

(You can graph other types of regression equations and view their regression coefficients, see "Graphing statistics" in the next chapter.)

Regression equations have three important values: a, b, and r.

The correlation coefficient shows the quantitative relationship between x and y for a particular sample. It measures how well the regression line fits the data points.

The value of r is between -1 and 1. If r equals -1 or 1, all points on the correlation diagram are on a straight line.

The further the value of r is from -1 or 1, the fewer the number of points will be found massing about the line. The closer the value of r is to 0, the less reliable the correlation. If r is more than 0, it shows a positive correlation (as x increases, y increases); if r is less than 0, it shows a negative correlation (as x increases, y decreases).

Example:

How dependent is a person's weight on their height? Determine the regression equation for the following ten people. Here is the data (in centimeters and kilograms):

1	186	84
2	184.8	<i>7</i> 9.5
3	165	65.9
4	180	77.2
5	177	80.5
6	172.5	70.5
7	180	65
8	172.2	55
9	186	81.8
10	169.5	62

Enter statistics mode, clear any previous data, and enter the above data.

Press: MENU D 2 ENTER 3

(Deletes all data and selects two-variable data mode.)

Press: 186 [ENTER] 84 [ENTER] 184.8 [ENTER] 79.5 [ENTER]

(This enters the first two pairs) continue entering the remaining pairs. After entering the data, review it using the cursor keys to make sure it was entered correctly.

Using Statistics

View the regression coefficients by pressing MENU A 3. The results are:

a= -105.8750968

b= 1.004033259

r= 0.747255362

Therefore the linear regression equation is y=-105.87+1.00x.

In calculation mode, you can use the x' and y' functions to estimate values for x and y, and you can use all of the statistical results presented above in equations and programs.

Example:

After completing the previous example determine the

expected weight of a man 183 centimeters tall. What is

the expected height of a 60 kilogram man?

Press:

MENU 1 183 MATH G 5

Result:

77.86298958

The 183 centimeter man weighs

about 78 kilograms.

Press:

60 MATH G 4

Result:

165.2087671

The 60 kilogram man is a little over

165 centimeters.

Note:

Statistics mode and calculation mode regression values are always based on linear regression, even if another type of regression is selected in statistic graph mode.

Moving through the data

Besides using \triangleleft and \triangleright to page through the cards, you can use the statistics menu to move to the first, the last, or a designated card by pressing $\boxed{\text{MENU}}$. Press $\boxed{\equiv}$ $\boxed{\text{MENU}}$ $\boxed{\text{B}}$, and the following menu appears:



☐FIRST moves you to the first data card. (same as 2ndF ◄)

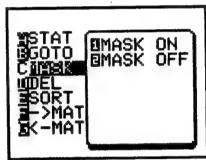
■ LAST moves you to the last data card. (same as 2ndF)

EANY CARD asks you to enter a card number. Enter the number of the card you want to see. If you enter a number greater than the last card number, the last card appears.

Masking unwanted data

You can exclude, or mask, unwanted or unusual values from the statistic calculations, while retaining them as input data.

Recall the card you want to mask or unmask on the screen. Press MENU C and the following menu is displayed:



IMASK ON excludes the current data card from the statistics calculations.

B MASK OFF includes the current card in the statistics calculations.

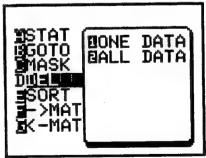
When a card is masked an [M] appears at the top of the card.

Deleting data

You can delete a single card or all of the data cards.

To delete a single card, you must go to the card you want to delete.

Press MENU D and the following menu is displayed:



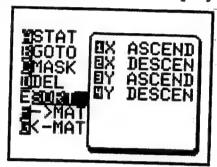
I ONE DATA deletes the selected card.

EALL DATA deletes all of the cards. You will be asked to confirm this selection, if you want to delete all of the cards, press ENTER.

Sorting data

You can sort the data cards in four different ways.

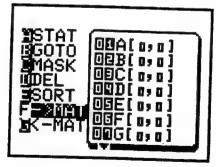
Press MENU E and the following menu is displayed:



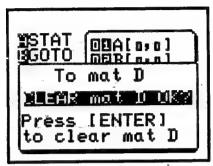
- ASCEND sorts the cards from the lowest x value to the highest.
- **EX** DESCEN sorts the cards from the highest x value to the lowest.
- EY ASCEND sorts the cards from the lowest y value to the highest. This function is not available in one-variable format.
- **DY DESCEN** sorts the cards from the highest y value to the lowest. This function is not available in one-variable format.

Transferring data to a matrix

To transfer the data that has been entered on cards in statistic mode to a matrix, press MENU F. The following menu appears:



Select a destination matrix. (Matrices with [0,0] listed as their dimensions are empty.) If the selected matrix is not empty, you will get a warning message:



Press **ENTER** if you want to replace the contents of the matrix with the contents of the data cards.

The new dimensions of the matrix are displayed in the matrix list. The number of columns the new matrix has depends on the number of cards. Each data card is considered one column of the matrix. The new matrix can have up to three rows. The x values are considered the first row, the y values are the second row (or the weights for one-variable with weight), and the weight values are the third row. For example, if the data cards contained the following information: card 1: x=1, y=10; card 2: x=2, y=20; card 3: x=3, y=30; card 4: x=4, y=40, then the new matrix is:

The following is a list of the statistics modes and the way data is stored in matrices:

one-variable: row 1 contains the x-data

one variable with weight: row 1 contains the x-data

row 2 contains the weights

two variable: row 1 contains the x-data

row 2 contains the y-data

two variables with weight: row 1 contains the x-data

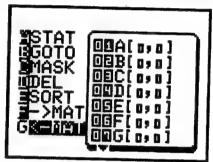
row 2 contains the y-data row 3 contains the weights

国Using Statistics

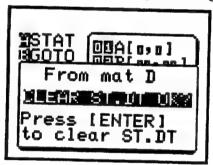
After data has been transferred to a matrix, all of the matrix functions and row operations are available. The matrix can be altered and then transferred back to the statistic cards for further analysis.

Transferring data from a matrix

To transfer data that has been entered in a matrix to data cards in statistic mode, press MENU G, the following menu appears:



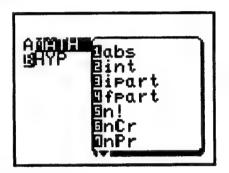
Select a source matrix. The matrix dimensions must be [1,x], [2,x], or [3,x]. [3,x] is weighted statistics, the third row contains the weights. If the data cards are not empty, you will get a warning message:



Press **ENTER** if you want to replace the contents of the data cards with the contents of the matrix.

Math functions

All of the function keys are available in statistics mode, and other math functions are available from the MATH menu. Functions can be part of an equation that is being entered in a card. After MATH is pressed, the following display appears:



These functions are described in Chapter 3.

The LEHYP menu contains the hyperbolic trigonometric function described in Chapter 3.

CHAPTER 7:

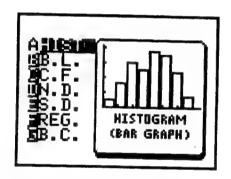
Graphing Statistics



Your calculator can draw six different types of graphs, and plot six types of regression curves in statistics graph mode.

Selecting statistics graph mode

To select statistics graph mode, press 2ndF . The following menu is displayed:



This menu lets you select a graph type. You can also select some of the graph functions described in Chapter 4 (for example, 2ndF PLOT).

Graphs can be drawn over each other for comparisons. Press 2ndF CA to clear all previously drawn graphs.

Graph types

The six different graph types are: histograms, broken-line graphs, cumulative frequency graphs, normal distributions, scatter diagrams, and box charts. The six types of regression are: Linear, exponential, logarithmic, logarithmic base 10, power, and inverse.

Histograms

Histograms plot only x-values. The horizontal position of the bar is the x-value. The height of the bar is the number of times (or percentage) that a particular x-value occurs in the data.

Example:

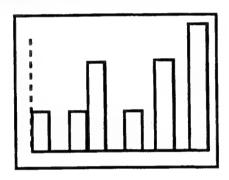
Plot the weight information of the last regression

example in Chapter 6.

Press:

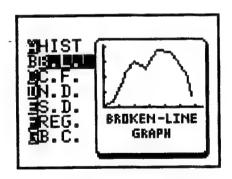
2ndF WE A 2ndF AUTO

Result:



Broken-line graphs

HB.L. draws a broken-line graph. Press 2ndF B and the following menu appears:



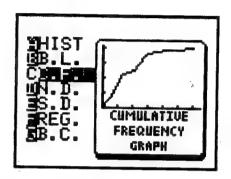
Press **ENTER** to graph over the histogram.

Broken-line graphs plot only x-values. The horizontal position of a point is the x-value, the vertical position is the number of occurrences of that x-value.

Note: To clear the graph screen, press 2ndF PLOT A ENTER.

Cumulative frequency graphs

MC.F. draws a cumulative frequency graph. Press 2ndF C and the following menu appears:

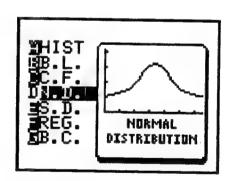


Press 2ndF AUTO to graph the data.

Cumulative frequency graphs show the sum of the number of occurrences of the x-values.

Normal distributions

M.D. draws a normal distribution. Press and the following menu appears:



Press 2ndF AUTO to graph the data.

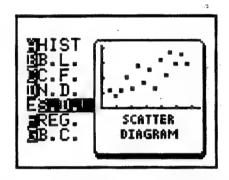
Normal distributions plot the relationship between the mean and the standard deviation of the x-values. The total area under a normal distribution is always equal to 1.

In all four of the above graph modes, you can move through the graphed data with \blacktriangleright and \blacktriangleleft . As you move along the graphs, the x and y coordinates appear at the bottom of the screen. In histogram, broken ine

and cumulative frequency graphs, and Box charts the cursor is at the right edge of the graphed data, but the coordinates displayed refer to the left edge. To change the viewing window, refer to the RANGE key description below.

Scatter diagrams

■S.D. draws a scatter diagram. Press 2ndF E and the following menu appears:



Scatter diagrams plot the x-values versus the y-values. Only two-variable data can be graphed.

Example:

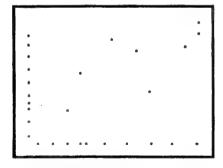
Plot the weight and height information in the

regression example above.

Press:

2ndF E 2ndF AUTO

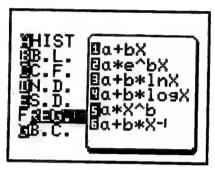
Result:



You cannot move through the scatter diagram with the cursor keys. If you want to see where the points lie, use the Plot FREE function described in Chapter 4.

Regression graphs

TREG. plots six different regression curves. Press 2ndF F and the following menu appears:



The following regression curves can be graphed:

■ Linear regression: a+bX

■ Exponential regression: a*e^bX

■ Logarithmic regression: a+b*lnX

■ Log base 10 regression: a+b*logX

■ Power regression: a*X^b

■ Inverse regression a+b*X⁻¹

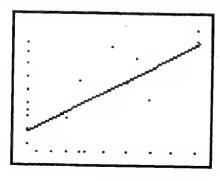
You can plot any or all of these curves on top of an existing graph.

Example: Plot linear and power regression curves on top of the previous scatter diagram.

Do the previous example. While the scatter diagram is displayed,

Press: QUIT F 1

Result:

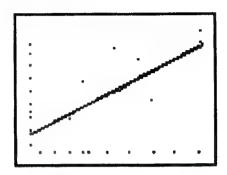


Graphing Statistics

Press:

QUIT F 5

Result:

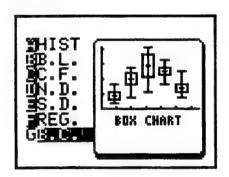


All of the regression curves will be similar through the data, however one curve is always closest to the actual data. You can compare the correlation coefficients to see which curve fits the data better. For more information see the section below called "The statistics graph menu."

You can move the cursor along the regression curve with \triangleright and \triangleleft . As you move along the curve, the x and y coordinates appear at the bottom of the screen.

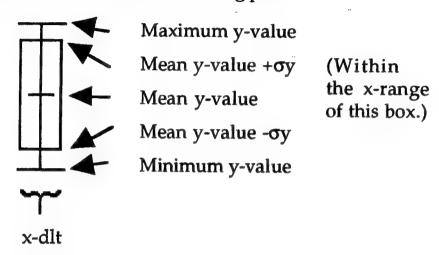
Box charts

IB. C. draws a box chart. Press QUIT to exit the previous example. Press G and the following menu appears:



Box charts plot the minimum, the maximum, the mean, and the standard deviation of y-values around a specific x.

You can move through the box chart graph with \triangleright , \triangleleft , \triangleright , \triangleright . As you move along the graph, the x and y coordinates appear at the bottom of the screen. You can move to the following points:



The graph keys

The following six keys affect graphs: MENU EQTN QUIT RANGE ZOOM PLOT AUTO.

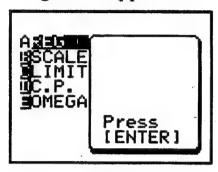
EQTN and QUIT return you to the statistics graph menu. Use them to exit the graph display and select a different type of graph function.

2ndF AUTO automatically scales the range. This is an easy way to quickly view graphs. 2ndF AUTO usually clears any old graphs, but if cumulative frequency (C.F.) or normal distribution (N.D.) are selected, they will be graphed over the existing data (even though the range has changed).

ZOOM and 2ndF PLOT perform the same functions described in Chapter 4.

The statistics graph menu

Press MENU and the following menu appears:



This menu displays regression coefficients, controls the scale, sets limits, and shows the process capability and omega conversion factors.

TREG shows the regression coefficients for the currently selected regression equation. Unlike the regression coefficients in statistics mode (which are always linear regression coefficients), these coefficients change when you select a new regression type.

ESCALE selects whether the data is graphed linearly or as percentage of the total. This function does not affect scatter diagrams, regression curves, or box charts.

LIMIT sets an upper and lower limit. Vertical bars are drawn on the screen at the limit points and at the mean value of x. The limit values are used to calculate process capability.

UC. P. displays process capability values.⁹

$${}^{9} \text{Cp} = \frac{\text{(upper limit-lower limit)}}{6\sigma}$$

$$Cpk = \frac{(upper\ limit\ -\ \tilde{x})}{3\sigma} \text{ or } \frac{(\tilde{x}\text{-lower}\ limit)}{3\sigma} \quad \text{whichever is less.}$$

■OMEGA displays the omega conversion values. 10

The RANGE key

As described in Chapter 4, RANGE lets you set the graph display range. If you specify a range, the number of points graphed depends upon the number of data cards. Since each point has a width expressed as a number of pixels (screen dots), it is important that the number of points in the selected range does not exceed the screen's width.

When you press [RANGE], a menu similar to the following appears:

Xdlt is the change in x each time you press ▶. This number directly affects the number of points plotted (n).

n is the number of points plotted. This number is limited by screen width. For histograms, broken-line graphs, and cumulative frequency graphs this number cannot exceed 31. For box charts this number cannot exceed 11. Do not confuse this number with the number of observations. They are not the same.

$$10 p = \frac{1}{1+10^{-(\frac{y}{10})}}$$

$$y = 10 \log (\frac{1}{p-1})$$

$$11 n = \frac{(X \max - X \min + \frac{(X \max - X \min)}{95})}{X d l t}$$

95 is the number of pixels across the screen used for graphing.

Graphing Statistics

If you enter Xdlt, n is recalculated. If you enter n, Xdlt is recalculated. Values that are too large produce errors.

CHAPTER 8:

Solving Equations

SOLVER

Note: Solver functions are available only on the EL-9300.

This chapter describes how to use the EL-9300's solver mode to solve equations. First, enter an equation. Second, assign values to the known variables. And lastly, use one of three methods to calculate the unknown variable. You can also create a library of frequently used equations.

The solver function can solve for any variable anywhere in an equation. It can even solve for a variable that appears several times in an equation.

Enter solver mode by pressing 2ndF SOLVER.

Entering equations

The first step in solving equations is to enter the equation into your calculator. You do not need to transform your equation for the unknown variable. Once the equation is entered, you can select any variable as the unknown.

The rules of arithmetic precedence, as discussed in Chapter 2, apply to the equations you enter. You can use any of the mathematical functions assigned to calculator keys and the functions found in the MATH menu; these include absolute value and hyperbolic trigonometric functions. Multiplication symbols are assumed (for example, 3z=2x+y is a valid equation), but you may need to enter them in some cases, such as between two lower case variables, to differentiate them from a two-letter variable name (for example, z=2xy is different than z=2x*y).

In solver mode, the case of your variables makes a difference:

- Single uppercase letters (A to Z and θ) are global variables. Global variables correspond to the memories of the calculator. (For example, C in an equation means memory C of the calculator.) Global variables allow your equations to use values stored in memories, or to pass variables from one equation to another. Global variables also allow you to store results from this mode to use in any mode. To use uppercase letters, press the ALPHA and 2ndF keys before pressing the letter.
- Lowercase letters, lowercase numbers (2ndF number), and lowercase words are local variables. (For example, you may choose to use c in an equation as a local variable.) Local variables exist only while the equation exists. When the equation is cleared, the local variables are cleared.
- Uppercase and lowercase letters cannot be mixed to form one variable. The single uppercase letters will always be taken as a single variable.

Your equation must include an equal sign (ALPHA ENTER).

Example:

Enter the equation to convert temperature between

Fahrenheit (degf) and Centigrade (degc):

 $degf = \frac{9}{5} degc + 32.$

Press:

2ndF SOLVER

Press:

EQTN CL

Clear any old equations.

Press:

2ndF A·LOCK degf= ALPHA 9 % 5 2ndF A·LOCK

degc ALPHA + 32 ENTER

If your equation is entered incorrectly, you may get the message ERROR 1: [Suntax1. Pressing or shows you the problem area of the equation.

Assigning values to the variables

After entering your equation, you need to assign values to the known variables. Global variables may already have values assigned to them, but you can change them for your calculation. As you assign variable values, the value is displayed below and to the right of the variable name.

Example:

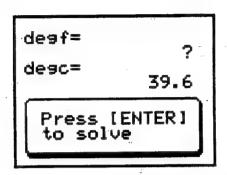
Convert 39.6 °C to Fahrenheit.

Press:

▼ 39.6 ENTER

ENTER

Select degf as the unknown.



The unknown variable has a question mark for its value.

Press:

ENTER

Solve the equation.

Result:

103.28

Solving equations

After you've moved the cursor to the variable that you want to solve for, press ENTER to solve the equation (it does not matter if the variable already has a value). BUSY is displayed at the top of the screen when drawing graphs and COMPUTING is displayed during the computation. The following screen shows the computational method used to solve the equation, and the result:

Equation solver

desf=
103.28

Press [ENTER]

After the equation is solved, you can press **ENTER** to display the variable list. You can change the values of the variables or select a different unknown and solve the equation again.

If the calculator cannot find a solution, you will get the message No solution in range or Calculate.

Press the **EQTN** key to display the equation if you need to edit it.

SOLVER Solving Equations

The next two examples demonstrate the convenience of entering an equation once, then using it to solve for different variables.

Example: Use the ideal gas law, pv=nRt, 12 to calculate the

universal gas constant (R) in SI units.

Press: EQTN CL Clear any loaded equation.

Press:

ALPHA p x 2ndF A·LOCK v = n 2ndF R tALPHA

ENTER

Enter the ideal gas law.

Press: 1.013 ENTER .0224 ENTER 1 ENTER ▼ 273 ENTER

You've entered standard conditions for p, v, n, and t.

Press: V V ENTER ENTER Select R as the unknown.

Result: 8.311794872 J/mole-K (0.000083117)

Example: Calculate the volume of 12 moles of oxygen at standard

conditions.

Press: ENTER A 12 ENTER ENTER

Result: $v=0.2688 \text{ m}^3$

v=volume (standard conditions: .0224 m³)

n=number of moles (standard conditions: 1)

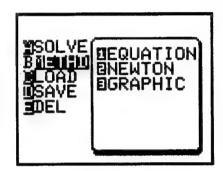
R=universal gas constant

t=temperature (standard conditions: 273 K)

¹² p= pressure (standard conditions: 1.013 N/m^2)

Solver methods

Solver mode has three methods for solving equations: Equation, Newton, and Graphic. To change the solver method, press MENU B, then select the desired method.



Equation method

The equation method is used when an exact solution can be found by simple algebraic methods (rearranging the variables to solve for the unknown). This is the default method. The previous temperature conversion and gas law examples were solved by this method

Newton method

For more complicated equations, the Newton method will be used. This is a numerical analysis method that uses an iterative technique to approximate the root. You must enter an initial estimate of the solution (START) and a step size (STEP) that it uses to determine successive estimates. It continues with this technique until the right and left sides of the equation are within a defined tolerance.

Example:	Calculate the interest rate for a \$5000 investment that			
-	will pay \$20000 in 5 years. Use the equation $s=p(1+i)^n$.			
Press:	EQTN CL Clear the loaded equation.			
Press:	2ndF $A \cdot LOCK$ $s = p$ $ALPHA$ () 1 + $ALPHA$ i) a^b			
	ALPHA n ENTER Enter the equation.			
Press:	20000 (ENTER) 5000 (ENTER) ▼ 5 (ENTER) ▼			
	ENTER Enter the known variables.			

The calculator automatically switches to the Newton method, because the equation cannot be solved using the equation method.

Press:

ENTER 0 ENTER 0.001 ENTER

Set the Newton solver parameters.

Newton solver

START=

STEP=

0.001

Press [ENTER]

Press:

ENTER

Result:

i=0.31950791

(A 32% return!)

The resulting display shows the solution and the value of the right and left sides of the equation. The RIGHT and LEFT values can be compared to determine the error in the solution. A large difference in these values may indicate an asymptote or discontinuity in the function; in this case, specify a starting point that moves the calculation away from the discontinuity or asymptote. The RIGHT and LEFT values may also differ if the solution is actually a local minimum or maximum. The closer these are, the more accurate the solution is likely to be. If the difference is great, the solution should not be considered accurate. If the error in the solution is large, set the START value slightly below the displayed solution and the STEP value slightly above. This may yield a more accurate answer.

If the parameters for the Newton solver are too restrictive, you get the error message ERROR 02 [Calculate]. For example, you will get this error if the starting value is too far from the solution or if the step size is too small.

Graphic method

The Graphic solver plots the right and left sides of the equation. If you lack the information to estimate a good starting point for your function with the Newton solver, then you should start with the Graphic solver. A graph of the function can be helpful for approximating multiple roots or determining discontinuities, asymptotes, or local minima and maxima.

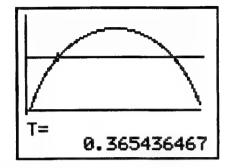
You must enter the range (BEGIN and END) where this method will look for a solution. If a root is found, a blinking cursor indicates the solution at the intersection of the two functions; the root is also displayed at the bottom of the screen. If you get the message No solution in range, you should enter another range to search for solutions. After you've found a solution, you can use the ZOOM function to view a portion of a graph in more detail. (For more information on this feature, refer to Chapter 4.)

Determine how long it will take a ball tossed Example: vertically in the air at 10m/sec to reach 3m. Use the equation for planar motion 0.5gt2+vt+dstart=d, where g is gravitational constant -9.8 m/s², v is initial velocity, d is distance, and T is time. Press: EQTN CL Clear the loaded equation. Press: MENU B 3 Use the Graphic solver. Press: 0.5 ALPHA g X ALPHA 2ndF T x2 + ALPHA v X ALPHA 2ndF T + 2ndF A-LOCK dstart = d ALPHA ENTER Enter the equation. (-) 9.8 ENTER ▼ 10 ENTER 0 ENTER 3 ENTER ▼ Press: ENTER] [ENTER] Enter the known variables, and solve for T. Press: 0 ENTER 2 ENTER Set the range. Graphic solver Variable range 0. END= 2. Press [ENTER]

Press: Result:

ENTER

Result: T=0.365436467



Note: A discontinuous function may be regarded as a continuous function to solve an equation

Equations with multiple roots

The solver stops processing when it finds the first solution for the equation. If there are other roots, you can change the solver parameters to search in a different range. For the Newton solver, you can change the START parameter; for the Graphic solver, you can change the BEGIN and END parameters, or if more than one solution is displayed on the screen, you can jump to the other solutions.

Example:

Find the second root of the above motion example.

Press:

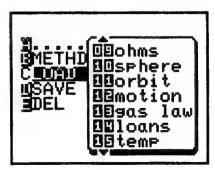
2ndF JUMP

Result:

T=1.675379859

The solver menu

Besides selecting the solver method, MENU lets you load, save, and delete equation files. Press MENU C and a menu similar to the following appears:



Loading equations

Before using an equation that you've saved, you must make it the active equation in the calculator. To load an equation, press MENU, select the LOAD option (C), then highlight the desired equation and press ENTER. Press ENTER to confirm that you want to clear the old equation and load the new equation. If there are no equation files, the right side of the screen will be empty.

Saving equations

You can save equations for future use, and set up an equation library of frequently used equations. To save an equation, press MENU D ENTER, then enter a name for the equation (up to 14 characters) and press ENTER.

Example:

Save the planar motion equation as motion.

Press:

MENU D ENTER

Select the SAVE function.

Press:

motion ALPHA ENTER Save motion.

Deleting equations

To remove an equation that you've saved, press MENU, select the DEL option (E), then select the desired equation. Press ENTER to confirm the deletion, or press QUIT to cancel. Equations listed below the deleted equation will automatically move on the list.

The option menu

The option menu lets you copy, move, and print equation files. See Chapter 2 for more information on using 2ndF OPTION.

CHAPTER 9:

Getting Results

This chapter contains solved problems from a number of fields that demonstrate the power of your Sharp calculator.

Math and physics

Geosynchronous orbits

The orbit of a satellite about the earth is a geosynchronous orbit if the period of the orbit matches the period of the earth's rotation. At what distance from the center of the earth can geosynchronous orbit occur?

The period of an orbit is described by the equation:

$$T^2 = \frac{4\pi^2}{GM} r^3$$

Where:

T = Period of orbit

G = Gravitational constant $(6.672 \times 10^{-11} \text{ Nm}^2\text{kg}^{-2})$

 $M = Mass of the earth (5.976 \times 10^{24} \text{ kg})$

r = Distance (radius) between the

satellite and the center of the earth

The earth rotates once every 23 hours, 56 minutes, and 4.09 seconds. Convert this time to seconds:

Press:

MENU A 1 23.560409

MATH D 1 X 60 x2 ENTER

Result:

86164.09 This is T.

Press:

STO T Store this in T.

Two of the numbers used in this equation only have three significant digits after the decimal point. Select scientific display format with three decimal places, and equation edit mode.

Press:

SET UP C 3 D 3 F 1 ENTER

On the EL-9300, use the solver to solve the equation for r.

Press:

2ndF SOLVER CL ALPHA 2ndF T (x2) ALPHA =

4 2ndF π x^2 %

ALPHA g X ALPHA m ALPHA r ab 3 ENTER

Select the graphic solver:

Press:

MENU B 3

2ndF RCL T ENTER 6.672 Exp (-) 11 ENTER

5.976 Exp 24 ENTER

Position the cursor on r and press **ENTER** to solve for r.

It's safe to assume that the orbit is above the surface of the earth (the earth's radius is approximately 6.378×10^6 meters), but less than 10 times that distance away. Set BEGIN to 6.378×10^6 and END to 6.378×10^7 .

Press:

6.378 Exp 6 ENTER

6.378 Exp 7 ENTER ENTER

Result:

4.217 E^{07} The radius in meters. About 42,170

kilometers from the center of the earth.

On the EL-9200, rearrange the equation to solve for r^3 :

$$r^3 = \frac{GMT^2}{4\pi^2}$$

Press:

(BB) 6.672 (Exp) (-) 11 x 5.976 (Exp) 24 x (2ndF) (RCL) T

 $x^2 \div (4 \times 2ndF \pi x^2) =$

Result:

 $7.498 E^{22}$ This is r^3 .

Press:

3 2ndF (a√ 2ndF) (ANS) (ENTER)

Result:

 $4.217 E^{07}$ The radius in meters.

Geosynchronous orbit occurs at a radius of 42,170 kilometers from the center of the earth.

Twinkle, twinkle, little star

The apparent magnitude of a star tells how bright it appears. The apparent brightness of a star is determined by how far away the star is and the luminosity of the star.

Since stars are seen from different distances, their luminosities must be standardized in order to be compared. This is done using a quantity called

the absolute magnitude. The absolute magnitude of a star tells how bright that star would appear if viewed from a distance of ten parsecs (about 32.6 light years). If the absolute magnitude of two stars is known, the ratio of their luminosities is:

$$\log \frac{L_2}{L_1} = 0.4 \ (M_1 - M_2)$$

Where:

 M_1 = the absolute magnitude of the

first star

M₂ = the absolute magnitude of the

second star

L₁ = the luminosity of the first star

L₂ = the luminosity of the second star

What is the ratio of the sun's luminosity to that of a star having an absolute magnitude of 2.89?

Rearranging the above equation:

$$\frac{L_2}{L_1} = 10^{0.4(M_1 - M_2)}$$

In this case, $M_2 = 2.89$.

Press:

SET UP C 1 F 1 ENTER 2ndF 10x

0.4 X () 4.8 -2.89 () ENTER

Result:

5.807644175

The star is nearly six times as

luminous as the sun.

A second star has only 0.0003 the luminosity of the sun. What is its absolute magnitude?

Rearranging the first equation to solve for M2:

$$M_2 = M_1 - \frac{\log \frac{L2}{L1}}{0.4}$$

In this case, $\frac{L_2}{L_1} = 0.0003$.

Press:

4.8 - () [log 0.0003 ÷ 0.4 |) [ENTER]

Result:

13.60719686

Radioactive decay

Carbon-14 (¹⁴C) is a naturally occurring radioactive isotope of carbon, used in the carbon dating process. Because carbon-14 decays at a steady rate, it is possible to determine the age of a once living specimen by measuring the remaining amount of ¹⁴C it contains. The mass of ¹⁴C contained in a sample changes according to this equation:

$$M = M_0 e^{-kt}$$
Where:
$$M = \text{mass of } ^{14}\text{C at time } t$$

$$M_0 = \text{original mass of } ^{14}\text{C}$$

$$k = \text{constant of decay}$$

$$(\text{for } ^{14}\text{C}, k = 1.2118 \times 10^{-4} \text{ year}^{-1})$$

$$t = \text{elapsed time in years}$$

Solving for t:

$$t = \frac{-\ln\left(\frac{M}{M_0}\right)}{k}$$

Write a program that asks for the starting and ending mass of 14 C, and tells you how old the specimen is.

Press: C ENTER 1 decay (ALPHA) (ENTER) 2ndF COMMAND A 1 2ndF COMMAND A 2 2ndF A-LOCK starting SPACE mass ALPHA ENTER 2ndF A·LOCK start ALPHA ENTER 2ndF COMMAND A 1 2ndF COMMAND A 2 2ndF A-LOCK ending SPACE mass ALPHA ENTER 2ndF A·LOCK end (ALPHA) (ENTER) 2ndF A·LOCK time = ALPHA (-) (in (2ndF A-LOCK end ALPHA (+) (2ndF) (A-LOCK) start (ALPHA) ())) ÷ 1.2118 Exp (-) 4 ENTER 2ndF COMMAND A 1 2ndF A-LOCK time ALPHA ENTER 2ndF COMMAND A 1 2ndF COMMAND A 2 2ndF A-LOCK years ALPHA ENTER

The finished program should look like this:

```
Print "starting mass
start
Print "ending mass
end
time=-(ln(end/start))/1.2118E-4
Print time
Print "years
```

To run the program, press MENU A, use the cursor keys to select the program, and press ENTER.

The half-life of an element is the time required for half of the mass to decay away. What is the half-life of (14C)?

Example:

Use the program to calculate the half-life of ¹⁴C. Run

the program.

start=?

Press:

100 ENTER

end=?

Press:

50 ENTER

Result:

5719.980034 years.

Exponential growth

Exponential mathematics can often give unexpected results. The following example illustrates this.

The town you live on relies on a certain resource for its existence. For years the town uses only one thousandth of the available resource every year, exactly the rate at which it is renewed. Suddenly, the town begins growing at a rate such that each year the town uses exactly twice as much of the resource as it did the year before.

How long will it take to use up the resource, and how long before then will your town notice the problem?

What you are concerned with is the amount of resource remaining. Before the change in the amount used, you could write the amount remaining each year as follows. (For simplicity, set the starting amount of the resource equal to 1.)

amount left =
$$1 + \frac{1}{1000} - \frac{1}{1000} = 1$$

During the first year of growth, the amount used is twice that of the previous year, or two-thousandths of the total. On the second year the amount used is four-thousandths, and so forth. The amount left at year X can be represented as:

amount left =
$$1 + \frac{1}{1000} - \frac{2^{X}}{1000}$$

Now use the graph trace feature to determine the amount of the resource remaining over the next few years.

Press: SET UP E 1 F 1 A

Enter the above equation.

Press: 1+1% 1000 - 2 a X/0/T 1000

RANGE MENU C 3 ▼ 10 ENTER 7

Determine the x-intercept,

Press: 2ndF JUMP 4
Result: x=9.967226, y=0

The resource would have been used up some time between the ninth and tenth years.

Looking only at the first 5 years, the town's people could be greatly misled about the amount of the resource left, and how long it would last. Even at the start of the ninth year almost half of the resource would still exist.

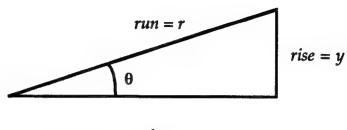
Engineering

Angle vs. percent grade

One street in your neighborhood was built on a 6% grade. Another has a slope of 3°. Which street is steeper?

The problem can be solved by converting either measurement into the units of the other and comparing the results. In this case, convert the percent grade into degrees of angle.

Grade equals *rise over run*. Percent grade is grade times 100. Notice that rise over run is the same as the *sin* of the angle.



$$\sin(\theta) = \frac{y}{r} = \frac{\text{rise}}{\text{run}}$$

The equation is:

$$sin(\theta) = 6\%$$

or:

$$\theta = \sin^{-1}(0.06)$$

Make sure DEG is selected. To convert a 6% grade to degrees:

Press:

SET UP B 1 ENTER 2ndF sin-1 0.06 ENTER

Result:

3.439812768

In degrees

The 6% grade can be rounded to a 3.44° angle. It is the steeper street.

Statistics

School days

Mr. Ringle teaches math at the local high school. He is giving his class a long and difficult test to see who qualifies for an advanced math program at the local university. Since the test is so difficult, he has decided to score using a standard Bell curve as follows: Anyone whose score is more than a standard deviation above the class mean score automatically qualifies for the advanced math program. Anyone who gets a score lower than a standard deviation below the class mean is eliminated. Those who score within a standard deviation of the mean will have to take another test to qualify.

The class scores are as follows:

499	427	375	300	227
487	425	371	291	198
474	420	360	272	162
468	413	352	268	140
462	401	349	264	115
455	396	327	256	97
453	390	322	255	65
433	384	.308	243	34

How many students qualify for the advanced program? How many are eliminated?

Start by entering the data in statistics mode.

Press:

圖 1

If the statistics memory isn't empty clear it

(MENU D 2 ENTER) and select single

variable data (X).

Press:

499 ENTER 487 ENTER 474 ENTER 468

(continue to enter all data items)

Now graph a histogram of the data and set limits at \bar{x} plus and minus one population standard deviation (σx) to see how many student qualify and how many are dropped.

Press:

2ndF MENU C 1 MATH E 1

- MATH 3 ENTER

MATH 1 + MATH 3 ENTER

EQTN A 2ndF AUTO

Result:

A histogram is drawn.

Change the range to get a clearer view of the data. Set Xd1 t to 20, Xmin to 30, and Xmax to 520.

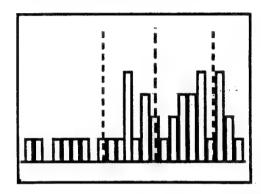
Press:

RANGE 20 ENTER

30 ENTER

520 ENTER EQTN ENTER

Result:



Using \triangleright and \triangleleft to look at the number of scores above and below the set limits shows that seven students qualify, and seven others are eliminated.

Fun and games

Put on the bite

Mary visits the dentist, spending exactly 25 minutes in his office. The bill for her visit comes to \$93.50. What is the dentist's equivalent wage per hour?

Press:

SET UP C 1 ENTER 93.50 ÷ 0.25

MATH D 1 ENTER

Result:

224.4

\$224.40 an hour.

The lottery

The state you live in has two different lotteries. In the first, you must pick six digits between 1 and 50, in any order. In the second, you have to pick five digits between 1 and 35, but you must pick them in the correct order. Which lottery gives you a better chance of winning?

In the first lottery, your chances of winning with one ticket are one in $50C_6$:

Press:

50 MATH A 6 6 ENTER

Result:

15890700.

Your chances of winning the second lottery with one ticket are one in 35P5:

Press:

35 MATH A 7 5 ENTER

Result:

38955840.

Your chances are better in the first lottery.

Boxing

Cliff has built a small wooden chest that measures $6\frac{1}{2} \times 8\frac{1}{2} \times 12$. A customer comes into his shop one day, and asks if she could get a similar box, only $\frac{1}{4}$ larger. What size box would Cliff have to build?

To get the size of the new box, multiply the dimensions of the existing box by $\frac{5}{4}$. Before you start the calculation change the answer mode to mixed.

Press:

SET UP G 2 ENTER

5 % 4 STO A

ALPHA Ax () 6 + 1 % 2 ENTER

Result:

 $8\frac{1}{8}$

Press:

ALPHA AX (8 + 1 % 2 ENTER

Result:

 $10\frac{5}{8}$

Press:

ALPHA Ax 12 ENTER

Result:

15.

The new box's dimensions would be $8\frac{1}{8} \times 10\frac{5}{8} \times 15$.

APPENDIX A:

Replacing the Batteries

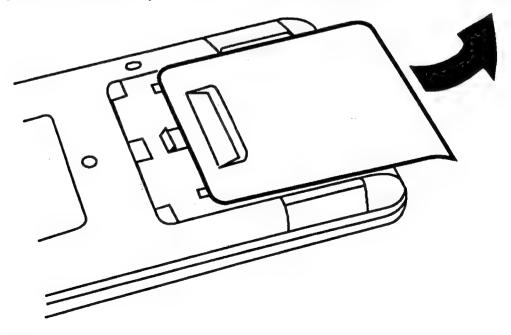
The calculator uses two types of batteries; 4 AAA batteries power the calculator and screen, and in the EL-9300, a lithium battery provides backup power. With normal use, the AAA batteries last about 6 months (or 140 hours), and the lithium backup battery lasts 5 years.

Note: To prevent loss of stored data, replace only one type of battery at a time.

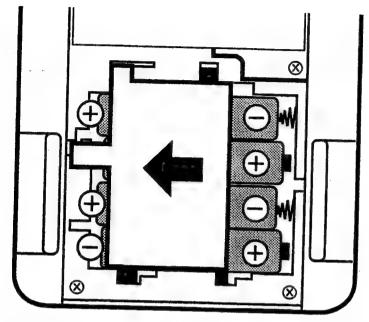
When **EATT** appears in the display, replace the AAA batteries as follows:

Note: If you continue using the calculator after **EATT** has been displayed, power may not turn on after ON is pressed. When BACKUP BATTERY LOW warning message appears on the EL-9300 after ON is pressed, replace the backup battery first.

- 1. Turn the calculator off by pressing 2ndF OFF.
- 2. Turn over the calculator and locate the battery compartment cover.
- 3. Pull the cover out a short distance until it stops, then lift the cover off the calculator, as shown in this illustration:



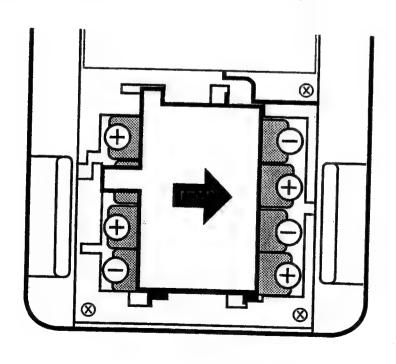
4. Carefully slide the AAA-battery plate to the left until it stops:



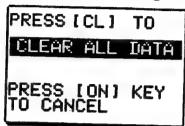
5. Lift off the plate and replace the batteries. Be sure to orient the batteries as shown in the above illustration.

Caution for EL-9200: Once the 4 AAA batteries are out, they should be replaced within 1 minute to prevent loss of stored data.

6. Replace the plate and slide it to the right:



- Replace the battery compartment cover.
- Press the reset button. The following message appears.



If you don't see the message, try again (repeat steps 1 to 7).

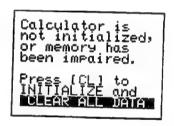
9. Press ON.

Caution: Do not press CL. This will clear all data.

10. Adjust the display contrast.

(Press 2ndF OPTION and press + or - until the contrast is set correctly.)

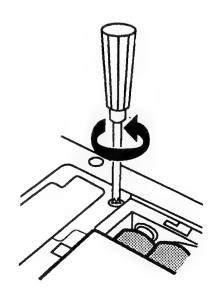
Note: For the EL-9200, if battery replacement took more than 1 minute in step 5, the following message may appear when ON is pressed. If this occurs, press CL to initialize the calculator and clear all data.



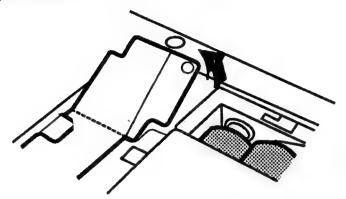
On the EL-9300, when BACKUP BATTERY LOW warning message appears, after power is turned on by ON being pressed replace the battery as follows:

Note: If you continue using the calculator after the backup battery warning message has been displayed, power may not turn on and you risk losing all of the stored memory.

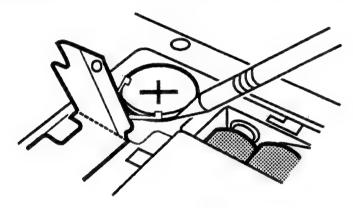
- 1. Open the battery compartment cover following steps 1, 2 and 3 of the previous procedure.
- 2. Using a small Phillips screwdriver, unscrew and remove the screw holding the backup battery cover:



3. Carefully tilt the cover up:



4. Using a pen or the screwdriver as a lever, lift the battery out of its compartment:



- 5. Replace the battery with an identical 3V lithium battery (CR2032 or equivalent). Make sure that the plus (+) sign faces up.
- Replace the battery cover and the screw.
- 7. Replace the battery compartment cover.

APPENDIX B:

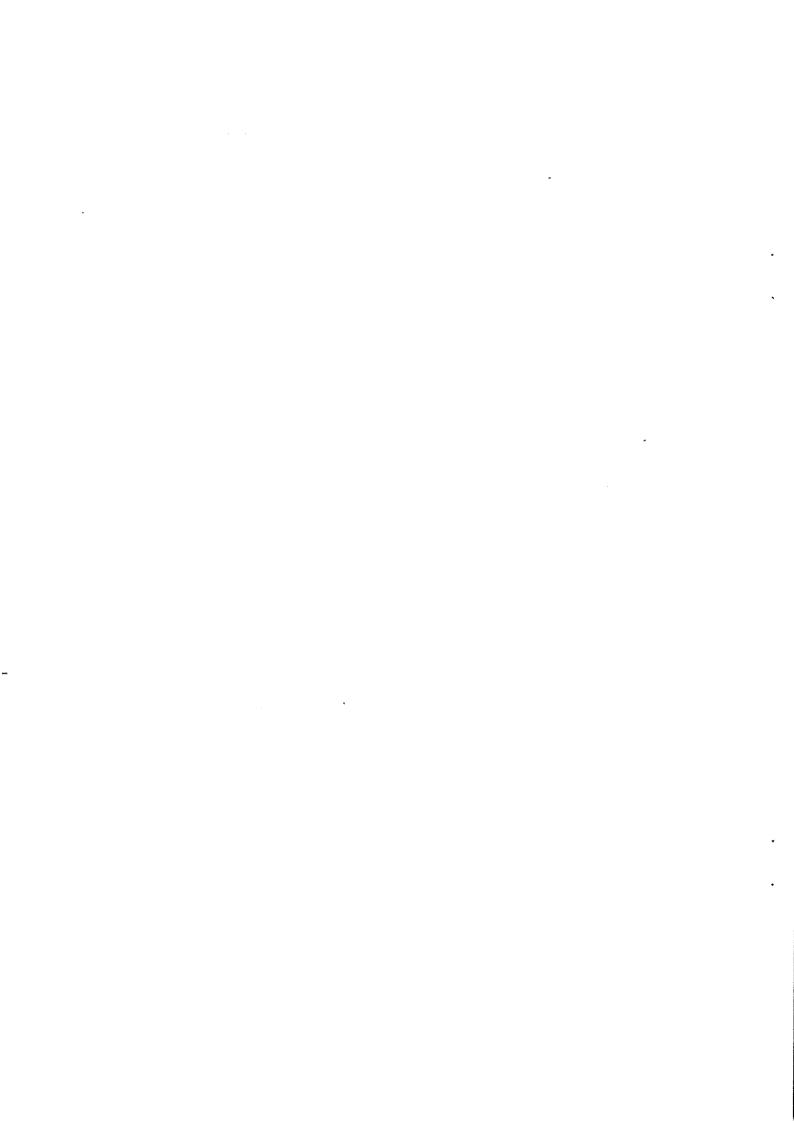
Error Messages

The following is a table of common error messages and suggestions for correcting the cause of the error:

Error Number	Error Message	Solution
01	Syntax	Use this manual to verify that you are using the proper syntax for the function you are trying to use.
02	Calculate	Check that you haven't attempted to divide by zero or make some other calculation error.
03	Nestins .	Make sure your calculations have less than 14 numbers and 32 functions within sets of nested parentheses.
05	Dimension	Check that the dimensions of all matrices being added, subtracted, and multiplied are compatible with each other. If you are trying to set the dimension of a matrix, make sure that there is enough memory available.
07	No arsument	Check that the faulty function has an argument.
08	Not pair ∫~dx	Check that every J is paired with a dx.
09	Not pair [~]	Check that every [is paired with a].
10	Line over	Equation edit mode only: your equation has run off the top or the bottom of the screen.
11	Cannot delete	You are trying to delete a function that cannot be deleted.

12	Buffer over	Equation edit mode only; buffer overflow.
13	Too many var.	Make sure you are using less than 20 variables. Solver mode only.
14	No variable	Make sure that all variables in the faulty line are defined. (Solver mode only)
20	Lbl duplicate	Make sure that your program doesn't use the same label name more than once.
21	Lbl undefined	Make sure your program doesn't have a Goto or Gosub to a label that doesn't exist. You can, however, use a label without referencing it in the program.
22	Lbl over	Make sure your program doesn't have more than 50 (12 for EL-9200) labels.
23	Gosub stack	Make sure your program doesn't have more than ten subroutines nested within each other.
24	Line too lons	Make sure the faulty line has less than 160 (128 for EL-9200) characters.
25	No graph	Check that the Graph command has an equation specified. Do not try to zoom in on a graph that has not been drawn.
26	Storase full	Make sure there are less than 99 files in the current mode. If necessary, delete unneeded files.
27	No STAT DATA	You must enter statistical data before drawing a statistical graph.
28	Wrona ST.Mode	Check that the proper statistical mode is set for the function you are using.
29	n range error	In statistical graph mode the maximum value of n is over 31 (11 for box charts).

30	Can't return	A Return appears in a program, but no Gosub was specified.
70	I/O device	Cannot communicate through the options port. Check that the cable is secure, and that the other device is in the proper mode.
71	Wrona Mode	You are attempting to transfer data to another device that is in the wrong mode.
72	Verify	Information on the cassette does not match the information on the calculator.
90	Memory over	There is not enough memory for what you are trying to do. Delete unneeded files and try again.
99	System error	The system memory is full.
(no number)	BREAK	You have pressed ON to stop the program, graphing and solving calculation. Press or ▶ to go to the last executed command or press CL to go to the program menu.



APPENDIX C:

Command Index

The following table lists all of the commands in alphabetical order.

In the syntax column <arg> is a number or a function that results in a number; for example, 4, 5+3, and sin 35(cos 12) are valid arguments.

The abbreviation <str> means a string of characters (a word or a letter).

Command	Description and keystrokes	Syntax	Page
S	MATH © 2 Integrate function. See also dx. Available in real mode only.	farg1, arg2, arg3, arg4 dx arg1, arg2, arg3 and arg4 are expressions. arg1 is a function. arg2 is the initial value. arg3 is the final value. arg4 (optional) is the number of subintervals. The calculator uses 100 if no subinterval is specified.	49
₹	MATH E 1 Mean value of x data (previously entered in statistics mode). Available in real mode only.	No arguments.	52
ij	MATH F 1 Mean value of y data (previously entered in statistics mode). Available in real mode only.	No arguments.	53
σχ	MATH E 3 Population standard deviation of x data (previously entered in statistics mode). Available in real mode only.	No arguments.	52
ûЯ	MATH F 3 Population standard deviation of y data (previously entered in statistics mode). Available in real mode only.	No arguments.	53

π	$2ndF\pi$ Displays π .	No arguments.	41
	MATH E 2 2ndF∠ Polar coordinate separator. Available only in complex mode.	No arguments.	74
=	2ndF COMMAND C 1 ALPHA = Equal to. Available only while editing a program.	If arg1 = arg2 Goto str arg1 and arg2 are expressions. str is a label.	101
<	2ndF COMMAND C 2 Less than. Available only while editing a program.	If arg1 < arg2 Goto str arg1 and arg2 are expressions. str is a label.	101
<=	2ndF COMMAND C 3 Less than or equal to. Available only while editing a program.	If arg1 <= arg2 Goto str arg1 and arg2 are expressions. str is a label.	101
>=	2ndF COMMAND © 4 Greater than or equal to. Available only while editing a program.	If arg1 >= arg2 Goto str arg1 and arg2 are expressions. str is a label.	101
>	2ndF COMMAND C 5 Greater than. Available only while editing a program.	If arg1 > arg2 Goto str arg1 and arg2 are expressions. str is a label.	101
≠	2ndF COMMAND C 6 Not equal to. Available only while editing a program.	If $arg1 \neq arg2$ Goto str arg1 and $arg2$ are expressions. str is a label.	101
11	2ndF COMMAND (A) (2) Denotes the beginning of a character string. Available only while editing a program.	Print "str str is a string of characters or numbers.	102

	2ndF COMMAND F 7 (in stat program mode) MATH E 3 (in matrix mode) Open bracket. Used to reference matrix elements and with the dim function.	St[arg1,arg2] St is a stat program command. arg1 can be 1, 2 or 3(represents x,y or w,w). arg2 is a card number. alpha [arg1, arg2] alpha is a letter key representing the matrix. arg1 is an expression for the row. arg2 is an expression for the column.	66
]	2ndF COMMAND F B (in stat program mode) MATH E 4 (in matrix mode) Close bracket. Used to reference matrix elements and with the dim function.	St[arg1,arg2] St is a stat program command. arg1 can be 1, 2 or 3(represents x,y or w,w). arg2 is a card number. alpha [arg1, arg2] alpha is a letter key representing the matrix. arg1 is an expression for the row. arg2 is an expression for the column.	66
(-)	(-) Change sign.	(-) arg arg is an expression.	4
0	C Left parenthesis.	(arg) arg is an expression.	20
D	(I) Right parenthesis.	(arg) arg is an expression.	20
±	⊕ Add.	arg1 + arg2arg1 and arg2 are expressions.	5
<u>-</u>	Subtract.	arg1 - arg2 arg1 and arg2 are expressions.	5
X	X) Multiply.	arg1 x arg2 arg1 and arg2 are expressions.	5
÷	÷ Divide.	arg1 ÷ arg2 arg1 and arg2 are expressions.	5
10 ^x	(2ndF) (10*) Exponential.	10 ^{arg} arg is an expression.	44

2ndF	2ndF) Second function.	No arguments.	10
	Activates the yellow function marked above the next key you press.		
A-LOCK)	2ndF (A·LOCK) Alpha lock. Enters blue alpha symbols marked above the keys until you press (ALPHA).	No arguments.	10
%	% Fraction.	arg1 % arg2 arg1 and arg2 are expressions	40
a ^b	Power.	arg1 ab arg2 arg1 and arg2 are expressions	44
ALPHA	[ALPHA] Enters a blue alpha symbol marked above each key you press.	No arguments.	10
AUTO	2ndF (AUTO) Auto-scale. Available only in graph and stat graph mode.	No arguments.	86
® √	2ndF ⁴√ a th root.	arg1 a√ arg2 arg1 and arg2 are expressions	44
BS	Deletes character to left of cursor.	No arguments.	5
CA	2ndF CA Clears current calculation. In program mode, deletes entire program. In statistics mode, deletes entire card.	No arguments.	94
CL	Clears the current calculation.	No arguments.	8
cos	Cosine.	cos arg arg is an expression.	42
cos ⁻¹	2ndF cos ⁻¹ Inverse cosine.	cos ⁻¹ arg arg is an expression.	42
DEL	DEL Deletes character at the cursor position.	No arguments.	5
ENTER	ENTER Evaluates expression.	arg ENTER arg is an expression.	4

EQTN	EQTN Displays current equation (in graph mode) or displays statistics graph function (in statistics graph mode).	No arguments.	79
e _z	2ndF (e ^x) Exponential base <i>e</i> .	er arg arg is an expression.	44
INS	2ndF (INS) Inserts keystrokes at cursor location.	No arguments.	93
JUMP	2ndF JUMP Displays the jump menu.	No arguments.	85
0	Inserts i (the imaginary number). Available only in complex mode.	No arguments.	74
In	In Natural log.	In arg arg is an expression.	44
log	log Log in base 10.	log arg arg is an expression.	44
MAT	MAT Recalls matrix. You don't need to press (ALPHA) when selecting the matrix. Available only in matrix mode.	mat <i>alpha alpha</i> is a letter key.	63
MATH	MATH Displays the math functions menu. Functions vary depending on mode.	No arguments.	11
MENU	MENU Displays the menu for the current operation mode. Menu varies depending on mode.	No arguments.	12
OFF	2ndF OFF Turns the calculator off.	No arguments.	2
ON	ON Turns the calculator on.	No arguments.	2
OPTION	2ndF OPTION Displays the option menu.	No arguments.	28

		TNT .	
PLOT	2ndF PLOT	No arguments.	86
	Displays the plot menu.		
	Available only in graph mode.		
QUIT	QUIT	No arguments.	81
	Leaves the current menu, matrix,		_
	or program.		
RANGE	RANGE	No arguments.	76
	Adjusts graphing range.		
	Displays the range entry screen.		
	Available only in graph and		
	statistics graph modes.		
RCL	2ndF (RCL)	RCL alpha	9
	Recalls the value from a	alpha is a letter key.	
	variable.		
	You don't need to press ALPHA		
	when selecting the variable name.		l
		NT.	
SET UP	SET UP	No arguments.	12
	Adjusts the calculator parameters.		ŀ
	_		İ
	Displays the setup menu.		
sin	sin	sin arg	42
	Sine.	arg is an expression.	
sin ⁻¹	2ndF sin-1	sin ⁻¹ arg	42
	Inverse sine.	arg is an expression.	
STO	STO	arg STO alpha	37
	Stores a value in a variable.	arg is an expression.	
	You don't need to press ALPHA	alpha is a letter key.	
	when selecting the variable		
	name.		
tan	tan	tan arg	42
	Tangent.	arg is an expression.	
tan ⁻¹	2ndF (tan-1)	tan-1 arg	42
	Inverse tangent.	arg is an expression.	
X/0/ T	(X/ 0 /T)	No arguments.	9
	Enter X, θ , or T, depending on the		
	coordinate mode.		_
	Not available in matrix mode.		
	T	√ arg	44
	Square root.	arg is an expression.	77
x ²	x ²	arg [x²]	10
ٺ	Square.	arg is an expression.	43
		and its art expression.	

x -1	2ndF (x ⁻¹) Inverse.	arg [x-1]	44
		arg is an expression.	
ZOOM	ZOOM Displays the zoom money	Select item.	84
	Displays the zoom menu. Available only in the graphing		
	modes.		
SOLVER	2ndF)(SOLVER)	No arguments.	139
SOLVER	Enters solver mode.(EL-9300 only)	o contract of the contract of	139
		No arguments.	113
, "	Enters statistics mode.		
		No arguments.	91
	Enters program mode.		
严	Æ	No arguments.	75
	Enters graph mode.		
<u>لنند</u>	2ndF Lize	No arguments.	129
	Enters statistics graph mode.		
00		No arguments.	3
	Enters calculator mode.		
⇒bin	MATH D 4	arg →bin	55
	Changes to binary (base 2).	arg is an expression.]
	Available only in nbase mode.		
⇒dec	MATH D 2	arg →dec	55
	Changes to decimal (base 10).	arg is an expression.	
	Available only in nbase mode.		•
⇒des	MATH D 1	dd.mmss →deg	50
	Changes from sexagesimal to	dd.mmss is an expression.	
	degrees.	-	
	Available only in real mode.		
⇒dms	MATH D 2	arg →dd.mmss	51
	Changes to degrees, minutes, and	arg is an expression.]
	seconds (sexagesimal).	•	
	Available only in real mode.		
⇒hex	MATH D 1	arg →hex	55
	Changes to hexadecimal (base 16).	arg is an expression.	
	′		
	Available only in nbase mode.		
>oct	MATH D 3	arg →oct	55
	Changes to octal (base 8).	arg is an expression.	
	Available only in nbase mode.		

÷rθ	MATH D 3	arg1, arg2 →rθ	E1
	Changes to polar coordinates.	arg1 and arg2 are expressions.	51
	Calculator displays r, θ is	g and any any	
	stored in the θ memory.		
÷xy	MATH D 4	arg1, arg2 →xy	51
	Changes to rectangular	arg1 and arg2 are expressions.	
	coordinates.		
	Calculator displays x; y is stored in the Y memory.		
	Available only in real mode.		
а	MATH G 1	No arguments.	53
	First coefficient of linear		
	regression (y-intercept).		1
	Available only in real mode.	N	
a+bX	2ndFlize F 1	No arguments.	133
	Selects a linear regression graph.		
	Available only statistics graph		
	mode.		
a*e^bX	2ndFlee F 2	No arguments.	133
	Selects an exponential regression	, and the second	
	graph.		
	Available only statistics graph mode.		
a+b*InX	2ndF [52] F (3)	No arguments.	122
	Selects a logarithmic regression	S. S	133
	graph.		
	Available only statistics graph		
	mode.		
a+b*logX	2ndF E F 4	No arguments.	133
	Selects a logarithmic base 10		
	regression graph. Available only statistics graph		
	mode.		
а*Х^Ь	2ndF Lize F 5	No arguments.	133
	Selects a power regression		133
	graph.		
	Available only statistics graph		
1 101-1	mode.		
a+b*X-1	2ndF 🔛 F 6	No arguments.	133
	Selects an inverse regression		
	graph. Available only statistics graph		
	mode.		
· · · · · · · · · · · · · · · · · · ·			<u> </u>

abs	MATH A 1 Absolute value.	abs arg arg is an expression.	46
ALL DATA	MENU D 2 Deletes all statistics data. 2ndF OPTION E 4 (2ndF) OPTION E 3 for EL-9200) Deletes all statistics and matrix date.	No arguments.	31
ALL GRPH	2ndFOPTION E 1 Deletes all graph files.	No arguments.	31
ALL MEM.	2ndF OPTION E 5 (2ndF) OPTION E 4 for EL-9200) Deletes all files and all data.	No arguments.	31
ALL PROG	2ndF OPTION (E) 2 Deletes all program files.	No arguments.	31
ALL SOLV	(EL-9300 only) Deletes all solver files.	No arguments.	31
and	MATH E 1 Logical AND operation. Available only in nbase mode.	arg1 and arg2 are expressions.	56
ANS	2ndF ANS Most recent answer.	No arguments.	38
ANY CARD	MENU B 3 Goes to specified card. Available only in statistics mode.	Enter card number.	123
arg	MATH E 5 Returns the argument. Available only in complex mode.	arg arg arg is a complex expression.	74
Auto	2ndF COMMAND D 2 Selects a Y range and performs the specified graph command. Available only in real and stat programs.	auto graph command graph command is Graph, DotGraph, Fill, or any statistics graph command.	96
AUTO	ZOOM [5] Magnifies the graph. Available only in graph mode.	No arguments.	85
Ь	MATH G 2 Second coefficient of linear regression (slope). Available only in real mode.	No arguments.	53

B.C.	2ndF 🔐 G	I No seems	
13.0.	Draws a box chart from current	No arguments.	134
	statistical data.		
	Available only in statistics		1
	graph mode.		
B.L.	2ndF Let B	No arguments.	130
	Draws a broken line chart from		130
	current statistical data.		
	Available only in statistics		
D UED	graph mode.		
B. VER	2ndF OPTION G ENTER F Verifies that the data on a	No arguments.	35
	cassette tape matches calculator		
	data after a back-up. (EL-9300		
	only.)		
BKUP	2ndF OPTION G ENTER D	No arguments.	34
	Backs up data to a cassette		
	recorder or another calculator. (EL-9300 only.)		
BOX	[ZOOM] [1]	No arguments.	-
	Draws a box that becomes the	140 arguments.	84
f 1	new view window.		
	Available only in graph mode.		
BRNCH	2ndF COMMAND B	Select item	107
	Displays program branching		10/
	commands.		1
	Available in program mode only.		
C.F.	2ndF 🔛 C	No arguments.	101
	Draws a cumulative frequency	The migations.	131
	chart from current statistical		
	data.		
	Available only in statistics graph mode.		1
C.P.	MENU D	No arguments	
	Displays the process capability	No arguments.	136
	variables.		
	Available only in statistics		
	graph mode.		
CALC	MATH C	No arguments.	48
	Displays the calculus menu.		
	Available only in real and	i	- 1
	graph mode.		ļ

CLEAR	2ndF PLOT A	No arguments.	86
	Clears the graph. Available only in graphing and statistics graph mode.		
ClrG	2ndF COMMAND E 2 Clears graphics screen (doesn't affect text or change display modes). Available only in program mode.	No arguments.	97
ClrT	2ndF COMMAND E 1 Clears graphics screen (doesn't affect text or change display modes). Available only in program mode.	No arguments.	97
CMPLX	SETUP (H) Selects polar or rectangular complex coordinates.	Select item.	27
COMPLEX	MENU A 4 Enters complex mode to perform calculations with complex numbers.	No arguments.	40
conj	MATH E 6 Returns the complex conjugate. Available only in complex mode.	conj arg arg is a complex expression.	74
Connect	MENU © 1 Draws a vector graph. Available only in graph mode.	No arguments.	88
COORD	SETUP E Selects coordinate system.	Select item.	24
COPY	2ndF OPTION C Copies file. Available in program, solver, and graph modes.	Select item.	29
cosh	MATH B 2 Hyperbolic cosine.	cosh arg arg is an expression.	43
Cosh ⁻¹	MATH B 5 Inverse hyperbolic cosine.	cosh-1 arg arg is an expression.	43
CTRST	2ndF OPTION (A) Adjusts the display contrast.	Press the plus key to darken the screen or the minus key to lighten it.	28

Da ta	[2ndF] [COMMAND] [F] [5] Enters a new statistical data point in the next available card. Available only in stat programs.	Data[arg1, arg2, arg3] arg1, arg2, and arg3 are expressions. arg1 is an expression representing x. arg2 is an optional expression representing y or w. arg3 is an optional expression representing w. The arguments must be consistent with the selected statistics mode.	97
d∕dx(MATH © 1 Derivative function. Available only in real mode.	d/dx(arg1, arg2, arg3) arg1, arg2, and arg3 are expressions. arg1 is a function. arg2 is x, the value to calculate the derivative. arg3 is ∆x, the change in x.	48
Decimal	SETUP G 1 Displays fractional results as decimal numbers.	No arguments.	26
DEFLT	RANGE MENU (A) Selects the predefined default range for functions. Available only in graph mode.	Select item.	83
Dea	SETUP B 1 Sets degrees as the angular mode.	No arguments.	21
DEL	MENU D (program mode) Deletes program. MENU G (graph mode) Deletes graph. MENU D (statistics mode) Deletes cards or all statistics data.	Select item.	31
det	MATH E 6 Determinant of a square matrix. Available only in matrix mode.	det mat alpha alpha is a letter key.	67

dim	(WATH CE CO	11 11.1	
U1 III	MATH E 2 Sets the dimensions of a matrix.	dim alpha [arg1, arg2]	66
	You don't need to press ALPHA	alpha is a letter key representing the matrix.	
	when selecting the matrix.		
	Available only in matrix mode.	arg1 is an expression for the row.arg2 is an expression for the	
	See also [and].	column.	
DIRECT	2ndF PLOT B 1	Enter points.	0.6
	2ndF (PLOT) (C) (1)	Effect points.	86
	Accepts coordinates to plot a		
	point or a line.		
DispG	2ndF COMMAND E 4	No arguments.	97
	Shows the graphics screen.		"
	Available only while editing a		
	program.		
DispT	2ndF COMMAND E 3	No arguments.	97
	Shows the text screen.	<u>"</u>	ŀ
	Available only while editing a		
Dot	program.		
TO £	MENU C 2 Draws a dot graph.	No arguments.	88
	0 1		
DotGraph	Available only in graph mode.	Dug 16 de la company	
DOTOFAPA	2ndF COMMAND D 3 Draws a non-connected dot	DotGraph func1, func2, func3, func4	97
İ	graph.	func1 is the function to graph.	
	Available only while editing a	func2, func3, and func4 are	
	real program.	optional additional functions to	
		graph.	
DRG	SETUP (B)	Select item.	21
	Selects angular unit settings.	,	
dz	MATH C 3	farg1, arg2, arg3, arg4 dx	50
	Marks the end of an integration	arg1, arg2, arg3 and arg4 are	
	equation.	expressions.	
	See also f.	arg1 is a function.	
	Available only in real mode.	arg2 is the initial value.	
		arg3 is the final value.	
		arg4 (optional) is the number of	
		subintervals. The calculator uses 100 if no subinterval is specified.	
EDIT	B	Select item.	-
	Edits program.	Colour Helli.	24
	(SET UP) (F)		
	Selects edit mode.		
	The same and the s		J

End	2ndF COMMAND (A) (6) Marks the end of a program. Available only while editing a program.	No arguments.	98
Ens	SETUP C 4 Selects engineering notation.	No arguments.	22
EQUATION	MENU B 1 Selects equation solver. Available only in solver mode. SET UP F 1 Selects equation edit mode.	No arguments.	25
EXP	RANGE MENU C Selects the predefined range for exponential functions. Available only in graph mode.	Select item.	84
FACTOR	ZOOM (4) Sets zoom factor. Available only in graph mode.	Enter x and y factors.	85
Fill	2ndF COMMAND D B Draws graph and fills the space between two functions. Available only while editing a program.	Fill func1, func2 func1 is the function to fill below. func2 is the function to fill above.	98
FILL	MENU (A) (5) Selects the fill options. Available only in rectangular graph mode.	No arguments.	88
FIRST	MENU B 1 Goes to the first statistics card. Available only in statistics mode.	No arguments.	122
Fix	SETUP C 2 Selects fixed point display.	No arguments.	22
Float Pt	SETUP C 1 Selects floating point display.	No arguments.	22
fpart	MATH (A) (4) Fractional part.	fpart arg arg is an expression.	46
FREE	2ndF PLOT B 2 2ndF PLOT C 2 Draws points or lines on a graph using the cursor.	Use the arrow keys to move the cursor. Press ENTER to draw a point.	86

FSE	SETUP C	Select item.	22
	Displays notation menu.		
G(B.C.)	2ndF COMMAND G 6 Draws a box chart from current statistical data. Statistics mode must be either XY or XYW. Available only while editing a stat program.	No arguments.	98
G(B.L.)	2ndF COMMAND G 2 Draws a broken-line chart from current statistical data. Available only while editing a stat program.	No arguments.	98
G(C.F.)	2ndF COMMAND G 3 Draws a cumulative frequency chart from current statistical data. Available only while editing a stat program.	No arguments.	98
G(exp)	2ndF COMMAND H 2 Draws the best fit exponential regression curve from current statistical data. Statistics mode must be XY or XYW. Available only while editing a stat program.	No arguments.	99
G(HIST)	2ndF COMMAND G 1 Draws a histogram from current statistical data. Available only while editing a stat program.	No arguments.	99
G(inv)	2ndF COMMAND H 6 Draws the best fit inverse regression curve from current statistical data. Statistics mode must be XY or XYW. Available only while editing a stat program.	No arguments.	99

G(line)	2ndF COMMAND H 1 Draws the best fit linear regression line from current statistical data. Statistics mode must be XY or XYW. Available only while editing a stat program.	No arguments.	99
G(1n)	2ndF COMMAND H 3 Draws the best fit natural logarithmic regression line from current statistical data. Statistics mode must be XY or XYW. Available only while editing a stat program.	No arguments.	99
G(loa)	2ndF COMMAND (H) 4 Draws the best fit logarithmic regression curve from current statistical data. Statistics mode must be XY or XYW. Available only while editing a stat program.	No arguments.	99
G(N.D.)	2ndF COMMAND G 4 Draws a normal distribution curve from current statistical data. Available only while editing a stat program.	No arguments.	100
G(POW)	2ndF COMMAND H 5 Draws the best fit power regression curve from current statistical data. Statistics mode must be XY or XYW. Available only while editing a stat program.	No arguments.	100
G(S.D.)	2ndF COMMAND G 5 Draws a scatter diagram from current statistical data. Statistics mode must be XY or XYW. Available only while editing a stat program.	No arguments.	100

C			
Gosub	2ndF COMMAND B 4 Calls the specified subroutine.	Gosub str	100
	Available only while editing a	str is the label that marks the subroutine.	
	program.	subtourne.	1
	See also Label and Return.		
Goto	2ndF) (COMMAND) (B) (2)	Goto str	100
	Jumps to the specified label.	str is the label that marks the	100
	Available only while editing a	location to go to.	
	program.		
	See also Label and If.		
GRAPH	2ndF COMMAND D	Select item.	100
	Displays graphing program commands.		
		Graph func1, func2, func3, func4	
	Available only while editing real or stat program.	func1 is the function to graph.	
	2ndF COMMAND D 1	func2, func3, and func4 are optional additional functions to	1
	Draws a graph.	graph.	
	Available only while editing a	8P	
	real program.		
GRAPHIC	MENU B 3	No arguments.	143
	Selects the graphic method for		
	solving equations.	i	
UICT	Available only in solver mode.		
HIST	2ndF (2ndF) (A) Draws a histogram of the	No arguments.	129
	current statistics data.		
HYP	(RANGE) (MENU) (E)	Select item.	0.4
	Selects the predefined range for	beleet hent.	84
	hyperbolic trigonometric		i i
	functions.		
	Available only in graph mode.		
4	MATH E 1	No arguments.	74
	Inserts i (the imaginary number).		
	Available only in complex		
	mode.		
If	2ndF COMMAND B 3	If conditional expression Goto str	101
	Conditional branch.	conditional expression contains	IOI
	See also <, >, <=, >=, ≠, =, and	tests such as $<$, $>$, $=$, and so on.	
	Goto.	Goto is the only command that	
		can follow an İf statement.	
		str is the label that marks the location to go to.	[
		rocation to go to.	

•		imaga aya	1 = :
image	MATH E 4	image arg	74
	Imaginary portion.	arg is a complex expression.	
	Available only in complex mode.		
	See also real.		
Improp	SETUP G 3	No arguments.	26
IMPTOP	Displays fractional results as	i vo argaments.	26
	improper fraction.		
IN	ZOOM 2	No arguments.	85
	Magnifies graph.		100
	Available only in the graphing	·	
	modes.		
INEQ	2ndF COMMAND C	Select item.	101
	Displays program inequality		101
	commands.		
	Availables in program mode		
	only.		I
Input	2ndF COMMAND A 3	Input str	101
	Input number.	str is a local or global variable.	
	Available only while editing a		
	program.		
int	MATH A 2	int arg	46
	Integer value.	arg is an expression.	
INTERSEC	2ndF JUMP A 1	No arguments.	85
	Move to the intersection of two functions.		
	Available only in graph mode.		
ipart	(MATH) (A) (3)	ipart arg	16
1Pur	Integer part.	arg is an expression.	46
l ele e i		Label str	100
Label	2ndF COMMAND B 1 Marks a destination point for	str is a string of up to ten (eight	102
	branch statements.	for EL-9200) characters.	
	Available only while editing a		
	program.		
	See also Goto, Gosub, and If.		
LAST	MENU B 2	No arguments.	122
	Goes to the last statistics card.		
	Available only in statistics		
*	mode.		
LIMIT	MENU C	Select item.	136
	Sets limit on statistics graph.		
	Available only in statistics		
	graph mode.		

Line	2ndF COMMAND D 7 Draws line from coordinates x ₁ ,y ₁ to x ₂ , y ₂ . Available only while editing real and stat programs.	Line arg1, arg2, arg3, arg4 arg1, arg2, arg3, and arg4 are expressions for the coordinates x ₁ , y ₁ , x ₂ , and y ₂ , respectively	87
LINK	2ndF OPTION G Sends data to or receives information from a cassette recorder or another calculator. (EL-9300 only)	No arguments.	33
LIST	2ndF OPTION F 3 Prints a file. Available in program, graph, and solver mode. (EL-9300 only)	Select item.	33
LOAD	MENU E Retrieves previously saved graph. Available only in graph mode. MENU C Retrieves previously saved equation. Available only in solver mode.	Select item.	34 147
M.CHK	2ndF) (OPTION) (B) Displays memory usage.	No arguments.	28
MASK OFF	Display card, then press MENU C 2 Unmasks a statistics data card. Available only in statistics mode.	No arguments.	123
MASK ON	Display card, then press MENU C 1 Masks a statistics data card. Available only in statistics mode.	No arguments.	123
mat	MATH E 1 Recalls matrix. You don't need to press (ALPHA) when selecting the matrix. Available only in matrix mode.	mat alpha alpha is a letter key.	65
MATRIX	MENU A 3 Enters matrix mode to define matrix elements and perform matrix calculations.	No arguments.	4 O

MAX	[2ndF] JUMP [A] 3 Jump to the maximum of a function. Available only in graph mode.	No arguments.	85
mdf	MATH D 5 Modify function; replaces the stored value with the displayed value.	value mdf value is a decimal.	51
MIN	2ndF JUMP A 2 Jump to the minimum of a function. Available only in graph mode.	No arguments.	85
Mixed	SETUP G 2 Displays fractional results as mixed numbers.	No arguments.	26
MOVE	2ndF OPTION D Moves a file. Available only in graph, program, and solver modes.	Select item.	30
n	MATH E 6 Number of observations (previously entered in statistics mode). Available only in real mode.	No arguments.	52
n!	MATH (A) (5) Factorial.	arg! arg is an expression that evaluates to a positive integer.	47
NBASE	MENU A 2 Enters nbase mode to perform calculations in base 2, base 8, base 10, or base 16. Use MATH D to set the base. Available only in calculation mode.	No arguments.	40
nCr	MATH A 6 Calculate the number of combinations (the number of different groups of <i>r</i> items that can be made out of <i>n</i> objects).	arg1 C arg2 arg1 and arg2 are expressions. arg1 is n, the number of total items. arg2 is r, the number of items you want in the smaller group. n and r must be integers.	47

N.D.	2ndF D Draws a normal distribution graph from current statistical data. Available only in statistics graph mode.	No arguments.	131
nes	MATH E 4 Logical negate operation. Available only in nbase mode.	neg arg arg is an expression.	58
HEM	© New program.	No arguments.	91
NEWTON	MENU B 2 Selects the newton method for solving equations. Available only in solver mode.	No arguments.	143
no t	MATH E 3 Logical NOT operation. Available only in nbase mode.	not arg arg is an expression.	57
nPr	MATH A 7 Calculate the number of permutations (the number of different arrangements of r items that can be made out of n objects).	arg1 P arg2 arg1 and arg2 are expressions. arg1 is n, the number of total items. arg2 is r, the number of items you want in the smaller group. n and r must be integers.	47
OFF	MENU © 3 Turns off the limits. Available only in statistics graph mode.	No arguments.	136
OMEGA	MENU E ENTER Displays the OMEGA conversion function. Available only in statistics graph mode.	No arguments.	137
OH	MENU © 2 Turns on the limits. Available only in statistics graph mode.	No arguments.	136
ONE DATA	MENU D 1 Deletes one data card. Available only in statistics mode.	No arguments.	123

ONE LINE	SETUP F 2	No arguments:	25
	Selects one line edit mode.		
or	MATH E 2	arg1 or arg2	57
	Logical OR operation.	arg1 and arg2 are expressions.	
OUT	Available only in nbase mode.		
OUT	ZOOM 3	No arguments.	85
	Reduces graph.		
	Available only in graphing modes.		
Plot	2ndF (COMMAND) D 6	Plot arg1, arg2	102
,	Plots point at coordinates x,y.	arg1 and arg2 are expressions for	102
•	Available only while editing	the coordinates x and y,	
	real and stat programs.	respectively.	
PLOT	2ndF PLOT B	Select item.	86
	Plots points on a graph.		00
	Available only in graphing		
DI OTA	modes.		
PLOT1	MENU C	Select item.	88
	Selects connected or dot graphs.		
DLOTO	Available only in graph mode.		
PLOT2	MENU D	Select item.	88
	Selects sequential or simultaneous graphs.		
	Available only in graph mode.		
POWER	RANGE MENU B	Select item.	
	Selects the predefined range for	Select Rein.	84
	power functions.		
	Available only in graph mode.		
Print	2ndF COMMAND A 1	Print "str	102
	Prints characters.	str is a string of characters.	102
	Available only while editing a	Print arg	
	program.	arg is an expression.	
PRINT	2ndF OPTION F	Select item.	32
	Sends information to printer.		32
PROG	2ndF COMMAND A	Select item.	29
	Lists programming commands.		2)
r	MATH G 3	No arguments.	54
	Correlation coefficient.	-	J-32
	Available in real mode only.		
Rad	SETUP B 2	No arguments.	42
	Selects radians.	Ü	44

random	(MATH) (A) (B)	No arguments.	47
T GITGOIII	Generates a random number (between 0 and 1).		
Ranse	2ndF COMMAND D 4 Sets range for the graphing screen. Available only while editing real and stat programs.	range arg1, arg2, arg3, arg4, arg5, arg6, arg7 arg1, arg2, and arg3 are expressions for xmin, xmax, and xscale, respectively. arg4, arg5, and arg6 are expressions for ymin, ymax, and yscale, respectively. The yrange is required even if the Auto Graph function is used. arg7 is an optional expression for the number of data points for statistics graphs.	103
real	MATH E 3 Real portion. Available only in complex mode. See also image.	real arg arg is a complex expression.	74
REAL	MENU (A) (1) Enters real mode to perform calculations with real numbers.	No arguments.	40
RECIV	2ndF OPTION G ENTER C Receives data into the current mode from a cassette recorder or another calculator. Data must be saved and loaded in the same mode. (EL-9300 only.)	No arguments.	34
REG	MATH G Displays regression variables. Available only in real mode. MENU A Displays regression values Available only in statistics graph mode.	Select item. No arguments.	53 120
REG.	2ndF F Displays regression graphs. Available only in statistics graph mode.	Select item.	133

REG.G	2ndF COMMAND (H)	Select item	
, LLOID	Displays program regression	Select Item.	99
	graphing commands.		
	Availables in stat program		
	mode only.		
RESTR	2ndF OPTION G ENTER E	No arguments.	35
	Restores a back-up from tape.		
	(EL-9300 only.)		İ
	Tape interface must be connected.		1
Rem	2ndF COMMAND A 5	Rem str	_
716111	Remarks		103
	The Rem statement has no effect	str is an expression.	
	on program operation.		ł
	Available only while editing a		
	program.		
Return	2ndF COMMAND B 5	No arguments.	103
	Ends subroutine and resumes	i D	1 200
	operation at the line following the Gosub statement that called		l
	the subroutine.	j	ĺ
	Available only while editing a		
	program.		
row m.p.	MATH F 4	row m.p.(arg1, alpha, arg2, arg3)	71
	Multiplies row by scalar, adds to second row and stores result in	arg1 is an expression for the	
	second row and stores result in	multiplier.	
	Available only in matrix mode.	alpha is a letter key representing the matrix.	
		arg2 is an expression for the first row.	
		arg3 is an expression for the	
		second row.	
row mult	MATH F 3	row mult(arg1, alpha, arg2)	70
	Multiplies row by scalar. Available only in matrix mode.	arg1 is an expression for the multiplier.	
	n man mode.	alpha is a letter key representing	
		the matrix.	
		arg2 is an expression for the row.	
row Plus	MATH F 2	row plus(alpha, rag1, arg2)	69
	Adds two rows and stores result in second row.	alpha is a letter key representing	
		the matrix.	
	Available only in matrix mode.	arg1 is an expression for the first row.	
		arg2 is an expression for the second row.	

row swap	MATH F 1 Switches two rows of matrix. Available only in matrix mode.	row swap(alpha, arg1, arg2) alpha is a letter key representing the matrix. arg1 is an expression for a row. arg2 is an expression for a row.	68
RUN	(E) A Runs program.	Select item.	91
Rθ	SETUP E 2 Sets polar coordinates in graph mode.	No arguments.	24
R∠θ	SETUP (H) (2) Sets polar coordinates in complex mode.	No arguments.	27
S.ALL	2ndF OPTION G ENTER B Sends all data from the current mode to a cassette recorder or another calculator. (EL-9300 only)	No arguments.	34
SAVE	MENU F Saves graph function. Available only in graph mode. MENU D Saves equation. Available only in solver mode. 2ndF OPTION G ENTER A Saves files to a cassette.	No arguments.	147 34
SCALE	MENU B Displays scale. Available only in statistics graph mode.	Select item.	136
SCREEN*1	2ndF OPTION F 1 Selects normal printout. (EL- 9300 only)	No arguments.	32
SCREEN*2	2ndF OPTION F 2 Selects sideways printout. (EL-9300 only)	No arguments.	32
SCRN	MENU A Jumps to equations and functions. Available only in graph mode. 2ndF COMMAND E Displays screen commands. Available in program mode only.	Select item.	88

S.D.	2ndF E Draws a scatter diagram from	No arguments.	132
	current statistical data. Available only in statistics graph mode.		
SEND	2ndF OPTION G ENTER A Sends specified data from current mode to a cassette recorder or another calculator. (EL-9300 only)	No arguments.	33
Sequence	MENU D 1 Selects sequential graphing. Available only in graph mode.	No arguments.	88
Set	MENU C 1 Sets upper and lower limit values. Available only in statistics graph mode.	Enter values.	136
Simul	MENU D 2 Selects simultaneous graphing. Available only in graph mode.	No arguments.	88
sinh	MATH B 1 Hyperbolic sine.	sinh arg arg is an expression.	43
sinh ⁻¹	MATH B 4 Inverse hyperbolic sine.	sinh-1 arg arg is an expression.	43
St	2ndF COMMAND F 6 Recalls existing statistical value. Available only in stat programs.	St[arg1, arg2] arg1 is an expression that results in 1, 2, or 3, specifying the x, y, or w variable. arg2 is an expression specifying the data card number.	104
ST.G	2ndF COMMAND G Displays program statistical graphing commands. Availables in stat program mode only.	Select item.	99
STAT	2ndF COMMAND F Displays program statistical commands. Availables in stat program mode only.	Select item.	104

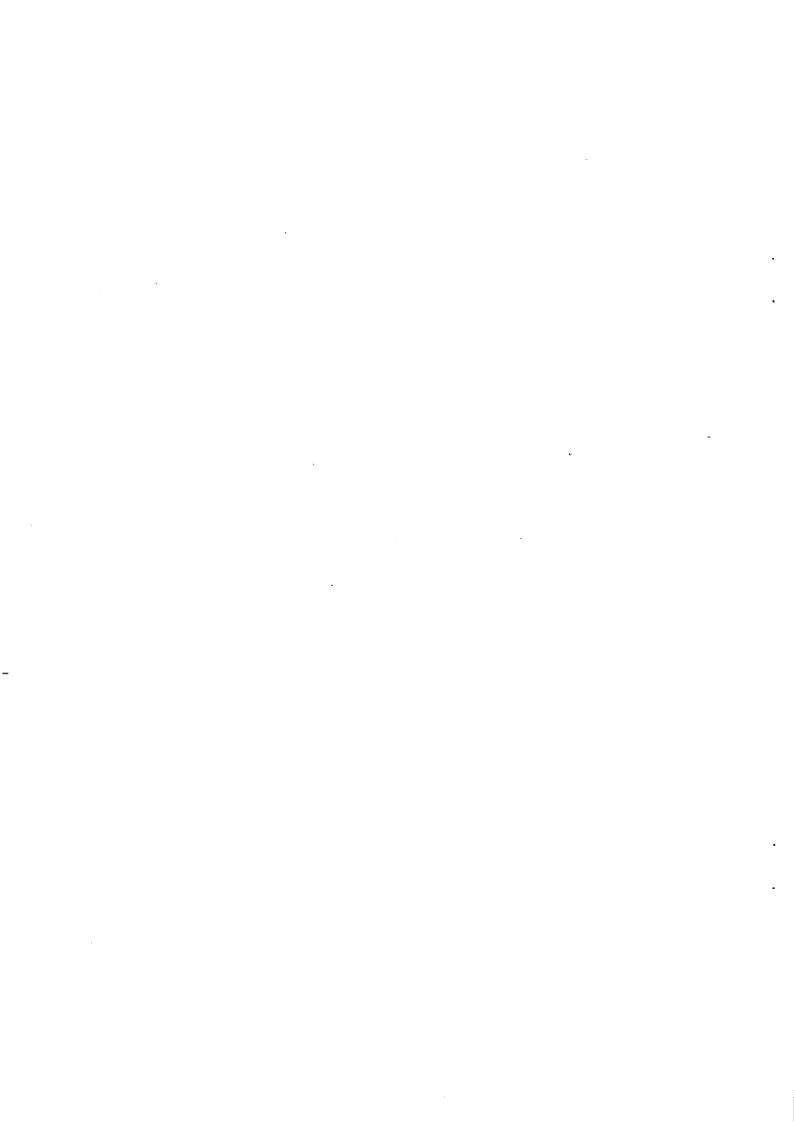
Stat X	2ndF COMMAND F 1	No arguments.	104
	Selects one-variable statistics mode.		
	Erases all data stored in the statistics cards.		
	Available only while editing a stat program.		
Stat XW	2ndF COMMAND F 2 Selects weighted one-variable statistics mode.	No arguments.	105
	Erases all data stored in the statistics cards.		
	Available only while editing a stat program.		
Stat XY	2ndF COMMAND F 3 Selects two-variable statistics mode.	No arguments.	105
	Erases all data stored in the statistics cards.		
	Available only while editing a stat program.		
Stat XYW	2ndF COMMAND F 4 Selects weighted two-variable statistics mode.	No arguments.	105
	Erases all data stored in the statistics cards.		
	Available only while editing a stat program.		
sχ	MATH E 2 Sample standard deviation of x data (previously entered in statistics mode).	No arguments.	52
7	Available in real mode only.	N	
Σχ	MATH E 4 Sum of x data (previously entered in statistics mode).	No arguments.	52
T2	Available in real mode only.		
Σ χ 2	MATH E 5 Sum of the squares of x data (previously entered in statistics mode).	No arguments.	52
	Available in real mode only.		

Σχυ	MATH F 6 Sum of the products of the xy data pairs (previously entered in statistics mode).	No arguments.	53
SA	Available in real mode only. [MATH] F [2] Sample standard deviation of y data (previously entered in statistics mode). Available in real mode only.	No arguments.	53
Σ9	MATH F 4 Sum of y data (previously entered in statistics mode). Available in real mode only.	No arguments.	53
∑y2 .	MATH F 5 Sum of the squares of y data (previously entered in statistics mode). Available in real mode only.	No arguments.	53
TAB	SETUP D Sets the number of decimal places.	Select item.	23
tanh	MATH B 3 Hyperbolic tangent.	tanh arg arg is an expression	43
tanh-1	MATH B 6 Inverse hyperbolic tangent.	tanh ⁻¹ arg arg is an expression	43
TRIG	RANGE MENU D Selects the predefined range for trigonometric functions. Available only in graph mode.	Select item.	84
trns	MATH E 5 Transposes matrix. Available only in matrix mode.	trns mat alpha alpha is a letter key.	66
VAR	MATH E Displays functions available for graphing. Available only in graph mode.	Select item.	88
VRIFY	2ndF OPTION G ENTER C Verifies that a file on cassette is the same as one in the calculator. (EL-9300 only) Available only when the cassette interface is connected.	Select item.	35

Wait		TW-:-	
WQ1 t	2ndF COMMAND A 4	Wait arg	105
	Waits for a specified number of seconds or until a key is pressed.	arg is an expression.	
	Available only while editing a		
	program.		
X ASCEND	MENU (E) (1)	No arguments.	124
	Sorts statistics cards in		12.7
	ascending order based on the x value.		İ
	Available only in statistics		
	mode.		
X DESCEN	MENU E 2	No arguments.	124
	Sorts statistics cards in		
	descending order based on the x value.		
	Available only in statistics		
	mode.		
X INCPT	2ndF JUMP A 4	Select item.	85
	Moves to the x intercept of		
	selected item.	i	
H 11050	Available only in graph mode.		
X-VARS	MENU A 1	No arguments.	1 18
	Displays the x variable statistics.		
ĺ	Available only in statistics		
	mode.		
z,	MATH G 4	arg x'	54
	Estimated value of x, based on		"
	linear regression.		
	Available in real mode only.	N	
zmaz	MATH E B Maximum x value from data	No arguments.	52
	(previously entered in statistics		1
	mode).		1 1
	Available in real mode only.		
zmin	MATH E 7	No arguments.	52
	Minimum x value from data		
	(previously entered in statistics mode).		
	Available in real mode only.		
znor	MATH E 6	arg1 xnor arg2	FC
	Logical XNOR operation.	arg1 and arg2 are expressions.	59
	Available only in nbase mode.	of many are expressions.	
	,		

xor	MATH E 5 Logical XOR operation. Available only in nbase mode.	arg1 xor arg2 arg1 and arg2 are expressions.	58
X+Yi	Sets rectangular coordinates in complex mode.	No arguments.	27
XYT	SETUP E 3 Selects parametric equations.	No arguments.	24
Y ASCEND	MENU E 3 Sorts statistics cards in ascending order based on the y value. Available only in statistics mode.	No arguments.	124
Y DESCEN	MENU E 4 Sorts statistics cards in descending order based on the y value. Available only in statistics mode.	No arguments.	124
Y INCPT	2ndF JUMP A 5 Moves to the y intercept of selected item. Available only in graph mode.	Select item.	85
Y-VARS	MENU A 2 Displays the x variable statistics. Available only in statistics mode.	No arguments.	119
y,	MATH G 5 Estimated value of y, based on linear regression. Available in real mode only.	arg y'	54
Y'	MENU B Determines derivative of the graphed function while using the trace function. Available only in graph mode.	Select item.	88
Y1	MATH E 1 Selects function Y1 for graphing. Available only in graph mode.	No arguments.	88

Y2	MATH E 2 Selects function Y2 for graphing. Available only in graph mode.	No arguments.	88
Y3	MATH E 3 Selects function Y3 for graphing. Available only in graph mode.	No arguments.	88
Y4	MATH E 4 Selects function Y4 for graphing. Available only in graph mode.	No arguments.	88
Ymax	MATH F B Maximum y value from data (previously entered in statistics mode). Available in real mode only.	No arguments.	53
9min	MATH F 7 Minimum y value from data (previously entered in statistics mode). Available in real mode only.	No arguments.	53
Zoom	2ndF COMMAND D 5 Adjusts the range of a graph. You must draw a graph before zooming. Available only while editing a real or stat program.	zoom arg1, arg2 arg1 is an expression for the zoom factor, 1/arg1. arg2 is an optional expression for the y zoom factor (in this case, arg1 is the x zoom factor).	84



APPENDIX D:

Technical Data

This appendix describes calculation accuracy and memory usage.

Accuracy

Entires and the four basic arithmetic operations, first and second operands, and calculation results must be within:

 $\pm 1 \times 10^{-99}$ to 9.999999999 x 10^{99} and 0.

Note The calculator regards absolute values of a numeric entry (or results of a calculation) less than 1×10^{-99} as 0 (zero).

Scientific and special functions:

Function	Dynamic range
SINx	DEG: $ x < 1x10^{10}$
COSx	RAD: $ x < \frac{\pi}{180} \times 10^{10}$
TANx	
	GRAD: $ x < \frac{10}{9} \times 10^{10}$
	With TANX, however, an error occurs in the following cases:
	DEG: $ x = 90(2n-1)$
	RAD: $ x = \frac{\pi}{2}(2n-1)$
	GRAD: $ x = 100(2n-1)$ (n=integer)
SIN ⁻¹ x	-1 ≤ x ≤ 1
COS-1x	

TAN-1x	$ x < 1x10^{100}$
LNx	$1x10^{-99} \le x < 1x10^{100}$
LOGx	
e ^x	$-1 \times 10^{100} < x < 230.2585093$
10×	$-1 \times 10^{100} < x < 100$
a ^b	a > 0:
	$-1 \times 10^{100} < b \text{ LOG a} < 100$
	a=0:
	$0 < b < 1 \times 10^{100}$
	a < 0:
	where b: integer or 1/b: odd number(b≠0)
	$-1 \times 10^{100} < b \text{ LOG } a < 100$
	b > 0:
$a\sqrt{b}$	$-1 \times 10^{100} < \frac{1}{a} LOG b < 100 \ (a \neq 0)$
	b=0:
	$0 < b < 1 \times 10^{100}$
	b < 0:
	where a is an integer or 1/a is an odd number(a≠0)
	$-1 \times 10^{100} < \frac{1}{a} LOG b < 100$
SINHx	-230.2585093 < x < 230.2585093
COSHx	
TANHx	
SINH-1x	$ x < 1 \times 10^{50}$
COSH-1x	$1 \le x < 1 \times 10^{50}$

TANH-1x	x < 1	
√x	$0 \le x < 1 \times 10^{100}$	
x ²	$ x < 1 \times 10^{50}$	
x-1	$ x < 1 \times 10^{100} (x \neq 0)$	
n!	$0 \le n \le 69$ (n: integer)	
nCr	$0 \le r \le n \le 69$ (r,n: integer)	
nPr		
Conversions:	converted result:	
→dec	DEC: x ≤ 9999999999	
→bin	BIN: $1000000000000000000000000000000000000$	
→oct	$0 \le x \le 01111111111111111111111111111111$	
→hex	OCT: $40000000000 \le x \le 77777777777$	
	$0 \le x \le 37777777777$	
	HEX: FDABF41C01 $\leq x \leq$ FFFFFFFFF	
	$0 \le x \le 2540BE3FF$	
Logical Operations:	BIN: $1000000000000000000000000000000000000$	
not	$0 \le x \le 01111111111111111111111111111111$	
	OCT: $40000000000 \le x \le 77777777777777777777777$	
	0 ≤ x ≤ 3777777777	
	HEX: FDABF41C01 ≤ x ≤ FFFFFFFFF	
	$0 \le x \le 2540BE3FE$	

	•
neg	BIN: $10000000000000001 \le x \le 1111111111111111$
	$0 \le x \le 01111111111111111111111111111111$
	OCT: $4000000001 \le x \le 7777777777$
	0 ≤ x ≤ 3777777777
	HEX: FDABF41C01 $\leq x \leq$ FFFFFFFFFF
	$0 \le x \le 2540 BE3FF$
All other logical	same as NOT and NEG
operations	
$\rightarrow r\theta$	$ x < 1 \times 10^{100} y < 1 \times 10^{100}$
	$\sqrt{x^2+y^2}$ < 1 x 10 100
	$ \frac{y}{x} < 1 \times 10^{100}$
→xy	$ r < 1 \times 10^{100}$
	Same as trigonometric functions apply to the angle.
→dms	$ x < 1 \times 10^{100}$
ightarrowdeg	
Statistics mode	$ x < 1 \times 10^{50}$
	$ y < 1 \times 10^{50}$
	$ \Sigma x < 1 \times 10^{100}$
	$\Sigma x^2 < 1 \times 10^{100}$
	$ \Sigma y < 1 \times 10^{100}$
	$\Sigma y^2 < 1 \times 10^{100}$
	$ \Sigma xy < 1 \times 10^{100}$
	$ n < 1 \times 10^{100}$
X	n ≠ 0

0.	n > 1
SX	
	$ \Sigma x < 1 \times 10^{50}$
	$\Sigma x^2 = \frac{(\Sigma x)^2}{2}$
	$0 \le \frac{\sum x^2 \cdot \frac{(\sum x)^2}{n}}{n-1} < 1 \times 10^{100}$
	n-1
σχ	n > 0
	$ \Sigma x < 1 \times 10^{50}$
	$ \Sigma x < 1 \times 10^{50}$ $\sum_{x=0}^{\infty} \frac{(\Sigma x)^2}{n} < 1 \times 10^{100}$
	$\sum x^2 - \frac{x^2}{n}$
	$0 \le \frac{n}{n} < 1 \times 10^{100}$
1 77	Samo as v sv sv
Ӱ́	Same as x̄, sx, σx
sy	
бу	
r	n>0
	$ \Sigma x < 1 \times 10^{50}$
	$ \Sigma y < 1 \times 10^{50}$
	$0 < (\Sigma x^2 - \frac{(\Sigma x)^2}{n}) (\Sigma y^2 - \frac{(\Sigma y)^2}{n}) < 1 \times 10^{-100}$
	$ \Sigma xy - \frac{\Sigma x \Sigma y}{n} < 1 \times 10^{100}$
	$ \Sigma y < 1 \times 10^{50}$ $0 < (\Sigma x^{2} - \frac{(\Sigma x)^{2}}{n}) (\Sigma y^{2} - \frac{(\Sigma y)^{2}}{n}) < 1 \times 10^{100}$ $ \Sigma xy - \frac{\Sigma x \Sigma y}{n} < 1 \times 10^{100}$ $\left \frac{\Sigma xy - \frac{\Sigma x \Sigma y}{n}}{\sqrt{(\Sigma x^{2} - \frac{(\Sigma x)^{2}}{n}) (\Sigma y^{2} - \frac{(\Sigma y)^{2}}{n})}}\right < 1 \times 10^{100}$
	$\left \begin{array}{c c} \mathbf{V} \left(\Sigma x^2 & \frac{1}{n} \right) \left(\Sigma y^2 & \frac{1}{n} \right) \end{array} \right $

b	n > 0
	$ \Sigma x < 1 \times 10^{50}$
	$ (\Sigma x)(\Sigma y) < 1 \times 10^{100}$
	$0 < \left \sum x^2 - \frac{(\sum x)^2}{n} \right < 1 \times 10^{100}$
	$ \Sigma xy - \frac{\Sigma x \Sigma y}{n} < 1 \times 10^{100}$
	$\begin{aligned} & (\Sigma x)(\Sigma y) < 1 \times 10^{100} \\ &0 < \left \Sigma x^2 \frac{(\Sigma x)^2}{n} \right < 1 \times 10^{100} \\ & \Sigma xy \frac{\Sigma x \Sigma y}{n} < 1 \times 10^{100} \\ &\left \frac{\Sigma xy \frac{\Sigma x \Sigma y}{n}}{\Sigma x^2 \frac{(\Sigma x)^2}{n}} \right < 1 \times 10^{100} \end{aligned}$
a	same as b except the following:
	$ b\bar{x} < 1 \times 10^{100}$
	$ \bar{y}$ -b \bar{x} < 1 x 10 100
y'	$ bx < 1 \times 10^{100}$
	$ a+bx < 1 \times 10^{100}$
x'	$ y-a < 1 \times 10^{100}$
	$ y-a < 1 \times 10^{100}$ $ \frac{y-a}{b} < 1 \times 10^{100}$
	* "

As a rule, the error of functional calculations is less than ±1 at the lowest digit of a displayed numerical value (at the lowest digit of the mantissa in scientific notation) within the above calculation ranges. When calculating SINHx and TANHx, x is a singular point when it is 0(zero). Near this point, errors accumulate, reducing the accuracy.

Complex Functions:

Function	Dynamic accuracy
SIN (x+yi)	x < 230
COS (x+yi)	y < 230
SINH(x+yi)	
COSH(x+yi)	·
TAN(x+yi)	x < 115
TANH(x+yi)	y < 115
SIN ⁻¹ (x+yi)	$ x < 10^{25}$
COS^{-1} (x+yi)	$ y < 10^{25}$
$SINH^{-1}(x+yi)$	
$COSH^{-1}$ (x+yi)	
TAN-1 (x+yi)	$ x < 10^{50}$
$TANH^{-1}$ (x+yi)	$ y < 10^{50}$
1	$ x < 10^{50}$
x+yi	$ y < 10^{50} \text{ (x+y} i \neq 0)$
$(x+yi)^2$	$ x < 10^{50}$
	$ y < 10^{50}$
	$ xy < 5 \times 10^{99}$
LOG (x+yi)	$ x < 10^{50}$
LN(x+yi)	$ y < 10^{50}$
$\sqrt{x+y}i$	$ \frac{y}{x} < 10^{100}$

Technical Data

10 ^(x+yi)	x < 100, y < 100	
e ^(x+yi)	x < 230, y < 230	
$(x+yi)^{(a+bi)}$	$ x < 10^{50}$	
	$ x < 10^{50}$ $ y < 10^{50}$ $ a < 10^{100}$ $ b < 10^{100}$	
	$ a < 10^{100}$	
	$ b < 10^{100}$	

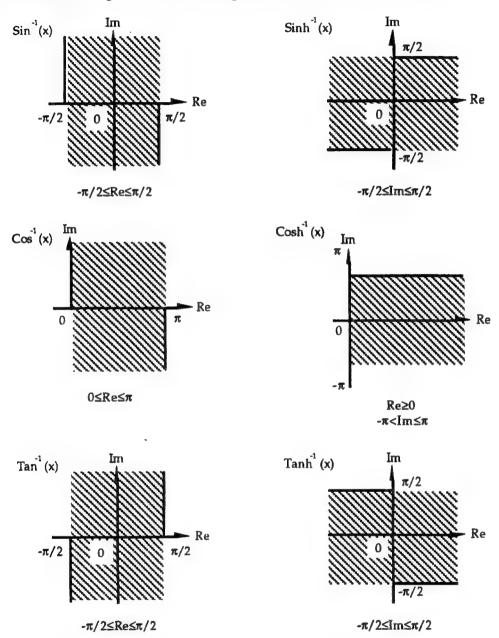
In complex number mode, the calculation error is normally ± 1 at the eight digit of the mantissa.

Calculations in $r\theta$ mode may generate a large calculation error.

The values near singularities cause large calculation errors.

In complex or $r\theta$ mode calculation speed is slower.

The calculator presets the range of solutions as follows:



In the above graphs, Re is real and Im is imaginary.

Memory usage

This section describes how the calculator uses memory in one line edit mode.

Note: Equation edit mode requires more memory due to the stored display commands.

Program mode

An empty program uses 35 bytes of memory.

Each line in a program uses 3 bytes plus the number of characters or commands on the line (each character or command uses 1 byte). For example, the two-line program shown below contains 6 characters and uses 45 bytes.

Program 35 bytes

Print A 3 bytes+2 bytes

Print B 3 bytes+2 bytes

35+5+5=45 bytes total.

Matrix mode

Each matrix uses 6 bytes plus 9 times the number of elements.

Graph mode

Each stored graph function uses 169 bytes plus the number of letters or commands. For example, a Y1=sin x uses 169+2 bytes.

Solver mode

Each stored solver equation uses 35 bytes plus the number of characters or commands.

APPENDIX E:

Specifications

Model: EL-9200/EL-9300

Display type: 16 columns X 8 rows (dot matrix character: 5 X 7 dots)

Calculation system: D.A.L.(Direct Algebraic Logic) result display (with priority judging function)

Number of display digits: 10-digit mantissa and 2-digit exponent

Number of internal calculation digits: 14-digit mantissa (Complex mode has 8-digit mantissas)

Display system: designation of numeric display system, calculation system, answer display system, and answer display system for complex numbers.

Calculation functions: Manual calculation (four basic arithmetic operations, calculations with parentheses, memory calculations, function calculations, numeric differential and numeric integral calculations, and coordinate conversion), binary/octal/decimal/hexadecimal conversion, logical operations, matrix operations, complex number calculations, complex variable function calculation (only in EL-9300), statistical calculations, etc.

Graphic functions: Rectangular coordinate graph, polar coordinate graph, parametric graph, range setting, automatic range setting (auto scaling), graph drawing, tracing, jumping, zooming, plotting, filling, graph formula storage, etc.

Program function: Conditional branch instructions, subroutines, graph instructions, etc.

Statistical input function: One-variable statistics input, two-variable statistics input, storage, deletion, weighted data input, data masking, sorting, etc.

Statistical graph function: Drawing of various statistical graphs, range setting, automatic range setting (auto scaling), process capability calculations, omega conversion, etc.

Solver function(only in EL-9300): Equation solver system; Formula syntactic analysis, Newton method analysis, graphic analysis, storage of solver equations, etc.

Options:Display contrast control, remaining memory check, data copy, data move, deletion, etc.

EL-9300 only: Display printing, data printing, and data communication.

Set up functions: Designation of angular unit, number display system, coordinate system for graph, calculation system, answer display system, and answer display system for complex numbers.

Memory capacity: EL-9300; 32 Kbytes (user area; 23,064 bytes) , EL-9200; 8 Kbytes (user area; 1,800 bytes)

Power supply: 6V-(DC); AAA type dry battery X 4 (for operation) 3V-(DC); lithium battery (CR2032) X 1 (for memory backup; only in EL-9300)

Auto power off: Approximately 7 minutes

Power consumption: 0.1 W

Operating temperature: 0°C to 40°C (32°F to 104°F)

Operating time: Approximately 140 hours (at 20°C (68°F) when each hour is 5 minutes of continuous operation and 55 minutes of display).

For memory backup (only in EL-9300); Approximately 5 years (at 20°C (68°F) with prompt replacement of AAA batteries when needed).

Note: These values may vary with the type of batteries and method of use.

Dimensions: 80 (W) X 182 (D) X 19.5 (H) mm (3 5/32 X 7 5/32 X 25/32 inch) (without hard case)

Weight: EL-9200 : 210g (0.46 lb.), EL-9300 : 220g (0.49 lb.) (including batteries, not including hard case)

Accessories: 4 AAA type batteries (included), 1 lithium battery (only installed in EL-9300) and Operation Manual.

APPENDIX F:

Function Count

The following tables list all of the EL-9300 calculator functions:

Basic functions

Operation	Туре	Total
Function buffer	32 functions, 14 numbers	46
Arithmetic calculations	+, -, x, +, (-), Exp	6
Memories	Α-Ζ, θ	27
Memory functions	STO, RCL	2
Last answer function	Ans	1
Play back function	Play back	1
Menu selection	Menu card	1
Editor function	CL, CA, DEL, BS, INS, ◀, ▶, ♠, ▼	9
Equation editor	Fraction, Exponent, Root, Absolute, Integrate symbol, Parentheses	6
Angle mode setup	DEG, RAD, GRAD	3
Display format setup	Floating point, Fix, Sci, Eng/TAB 0-9	14
Graphing mode setup	xy, rθ, xyt	3
Editor mode	Equation, One line	2
Display answer format	Decimal, Mixed, Improper	3
Complex answer format	x+yi, r∠θ	2

Calculation mode

Operation	Туре	Total
Trigonometric (in DEG, RAD, GRAD)	\sin , \cos , \tan , \sin^{-1} , \cos^{-1} , \tan^{-1}	18
Hyperbolic	sinh, cosh, tanh, sinh ⁻¹ , cosh ⁻¹ , tanh ⁻¹	6
Exponential and logarithmic	e ^X , 10 ^X , In, log	4
Power	$a^b, x^2, x^{-1}, a\sqrt{}, \sqrt{}$	5
Angle unit conversion	→dms, →deg	2
Coordinate conversion	→xy, →rθ	2
Factorial, permutation, combination	n!, nPr, nCr	3
Absolute, integer part, fractional part, integer	Abs, Ipart, Fpart, Int	4
Round	mdf	1
Numerical integration	∫dx, a~b, n	3
Numerical differentiation	d/dx, x, Δx	3
Random number generation	random	1
Pi	π	1
1-variable statistics	\bar{x} , sx, σx , Σx , Σx^2 , n, Xmax, Xmin	8
2-variable statistics	\overline{y} , sy, σy , Σy , Σy^2 , Σxy , Ymax, Ymin	8
Regression analysis	a, b, r(linear)	3
Estimation	x', y'	2
Complex calculations	x+yi, r∠θ, (x+yi)+(r∠θ)	3
Complex functions	sin, cos, tan, sin ⁻¹ , cos ⁻¹ , tan ⁻¹ , sinh, cosh, tanh, sinh ⁻¹ , cosh ⁻¹ , tanh ⁻¹ , log, ln, 10^x , e^x , a^b , $a\sqrt{}$, $\sqrt{}$, x^{-1} , x^2 , abs	22
Real part, imaginary part, angle, conjugate	Real, Image, Arg, Conj	4
N base	→bin, →oct, →hex, →dec	4
Conversion	bin↔oct↔dec↔hex	12

Logical operation	And, Or, Not, Neg, Xor, Xnor	6
Matrix memories	Mat A - Mat Z	26
Transposition, determinant, inverse, power, negation	Trns, Det, x^{-1} , x^2 , (-)	5
Row operations	Row swap, Row plus, Row mult, Row m.p.	4
Setting matrix size	Dim	1

Solver mode

Operation	Type	Total
Solving method	Equation, newton, graphic	3
Save solve equation	99 equations	1

Statistics mode

Operation	Туре	Total
1-variable statistics	\overline{x} , sx, σx , $\sum x$, $\sum x^2$, n, Xmax, Xmin	_
2-variable statistics	\overline{y} , sy, σy , Σy , Σy^2 , Σxy , Ymax, Ymin	
Regression analysis	a, b, r(linear)	_
Estimation	x', y'	_
Data format	1-variable with weight, 2-variable with weight	4
Select data card	First, Last, Any card	3
Data sorting	X-ascend/descend, Y-ascend/descend	4
Delete	1 data, All data	2
Mask	On/Off	1
Save statistics data	A-Z (common use with matrices data)	1

Statistical graphs	Hist, B.L., C.F., N.D., S.D., B.C.	6
Regression curve	$a+bX$, axe^{bX} , $a+bxlnX$, $a+bxlogX$, axX^b , $a+bxX^{-1}$	6
Statistics graph y-axis	Linear, %	2
Process capability	Limit setting, On/Off, Cpk, Cp	4
Omega conversion	y, p	2
Auto scaling	x-y axis auto scaling	1

Graphics mode

Operation	Туре	Total
Rectangular, Polar, Parametric	xy, rθ, xyt	_
Draw type	Graph, Auto (Y axis auto scaling)	2
Jump	Intersect, Min, Max, X incpt, Y incpt	5
Range setting, Range menu	Range, Default, Power(3), Exp(4), Trig(5), Hyp(6)	20
Zoom	In, Out, Box, Factor	4
Graph type	Multiple, Fill	2
Numerical derivative	On/Off	1
Plot1	Connect, Dot	2
Plot2	Sequence, Simul	2
Plot type	Plot (Direct, Free), Line (Direct, Free), Clear	5
Trace	Trace, Change tracing graph	2
Save graph equation	99 graph equations	1

Program mode

Operation	Туре	Total
Program type	Real, N-base, Matrix, Complex, Stat	5
Prog	Print, ", Input, Wait, Rem, End	6
Branch	Label, Goto, If, Gosub, Return	5
Inequality	<, <=, >, >=, =, ≠	6
Graph	Graph, Auto, DotGraph, Range, Zoom, Plot, Line, Fill	8
Scrn	ClrT, ClrG, DispT, DispG	4
Stat	Stat x/xw/xy/xyw. Data, St	6
Stat graph	G(hist), G(B.L.), G(C.F.), G(N.D.), G(S.D.), G(B.C.)	6
Reg graph	G(line), G(exp), G(ln), G(log), G(pow), G(inv)	6
Save program	99 programs	1

Option

Operation	Туре	Total
Screen and Memory	LCD contrast, Memory check	2
Data management	Copy, Move, Del	3
Data/Printer	Screen×1, Screen×2, List/Data	3
Data communications	Send, Send all, Backup	3

Total functions 437

The following tables list all of the EL-9200 calculator functions:

Basic functions

Operation	Туре	Total
Function buffer	32 functions, 14 numbers	46
Arithmetic calculations	+, -, x, +, (-), Exp	6
Memories	A-Z, θ	27
Memory functions	STO, RCL	2
Last answer function	Ars	1
Play back function	Play back	1
Menu selection	Menu card	1
Editor function	CL, CA, DEL, BS, INS,	9
Equation editor	Fraction, Exponent, Root, Absolute, Integrate symbol, Parentheses	6
Angle mode setup	DEG, RAD, GRAD	3
Display format setup	Floating point, Fix, Sci, Eng/TAB 0-9	14
Graphing mode setup	xy, rθ, xyt	3
Editor mode	Equation, One line	2
Display answer format	Decimal, Mixed, Improper	3
Complex answer format	x+yi, r∠θ	2

Calculation mode

Operation	Туре	Total
Trigonometric (in DEG, RAD, GRAD)	\sin , \cos , \tan , \sin^{-1} , \cos^{-1} , \tan^{-1}	18
Hyperbolic	sinh, cosh, tanh, sinh ⁻¹ , cosh ⁻¹ , tanh ⁻¹	6

Exponential and logarithmic	e ^X , 10 ^X , ln, log	4
Power	a ^b , x ² , x ⁻¹ , a√, √	5
Angle unit conversion	→dms, →deg	2
Coordinate conversion	$\rightarrow xy$, $\rightarrow r\theta$	2
Factorial, permutation, combination	n!, nPr, nCr	3
Absolute, integer part, fractional part, integer	Abs, Ipart, Fpart, Int	4
Round	mdf	1
Numerical integration	ʃdx, a~b, n	3
Numerical differentiation	d/dx, x, Δx	3
Random number generation	random	1
Pi	π	1
1-variable statistics	\overline{x} , sx, σx , $\sum x$, $\sum x^2$, n, Xmax, Xmin	8
2-variable statistics	\overline{y} , sy, σy , Σy , Σy^2 , Σxy , Ymax, Ymin	8
Regression analysis	a, b, r(linear)	3
Estimation	x', y'	2
Complex calculations	x+yi, r∠θ, (x+yi)+(r∠θ)	3
Complex functions	abs, x^{-1} , x^2	3
Real part, imaginary part, angle, conjugate	Real, Image, Arg, Conj	4
N base	\rightarrow bin, \rightarrow oct, \rightarrow hex, \rightarrow dec	4
Conversion	bin↔oct↔dec↔hex	12
Logical operation	And, Or, Not, Neg, Xor, Xnor	6
Matrix memories	Mat A – Mat Z	26
Transposition, determinant, inverse, power, negation	Trns, Det, x ⁻¹ , x ² , (-)	5

Row operations	Row swap, Row plus, Row mult, Row m.p.	4
Setting matrix size	Dim	1

Solver mode

Operation	Туре	Total
Solving method	Equation, newton, graphic	0
Save solve equation	99 equations	0

Statistics mode

Operation	Туре	Total
1-variable statistics	\overline{x} , sx, σx , Σx , Σx^2 , n, Xmax, Xmin	_
2-variable statistics	\overline{y} , sy, σy , Σy^2 , Σxy ,	
Regression analysis	a, b, r(linear)	
Estimation	x', y'	_
Data format	1-variable with weight, 2-variable with weight	4
Select data card	First, Last, Any card	3
Data sorting	X-ascend/descend, Y-ascend/descend	4
Delete	1 data, All data	2
Mask	On/Off	1
Save statistics data	A-Z (common use with matrices data)	1
Statistical graphs	Hist, B.L., C.F., N.D., S.D., B.C.	6
Regression curve	$a+bX$, axe^{bX} , $a+bxlnX$, $a+bxlogX$, axX^b , $a+bxX^{-1}$	6
Statistics graph y-axis	Linear, %	2

Process capability	Limit setting, On/Off, Cpk, Cp	4
Omega conversion	y, p	2
Auto scaling	x-y axis auto scaling	1

Graphics mode

Operation	Туре	Total
Rectangular, Polar, Parametric	xy, rθ, xyt	
Draw type	Graph, Auto (Y axis auto scaling)	2
Jump	Intersect, Min, Max, X incpt, Y incpt	5
Range setting, Range menu	Range, Default, Power(3), Exp(4), Trig(5), Hyp(6)	20
Zoom	In, Out, Box, Factor	4
Graph type	Multiple, Fill	2
Numerical derivative	On/Off	1
Plot1	Connect, Dot	2
Plot2	Sequence, Simul	2
Plot type	Plot (Direct, Free), Line (Direct, Free), Clear	5
Trace	Trace, Change tracing graph	2
Save graph equation	99 graph equations	1

Program mode

Operation	Туре	Total
Program type	Real, N-base, Matrix, Complex, Stat	5
Prog	Print, ", Input, Wait, Rem, End	6
Branch	Label, Goto, If, Gosub, Return	5
Inequality	<, <=, >, >=, =, ≠	6
Graph	Graph, Auto, DotGraph, Range, Zoom, Plot, Line, Fill	8
Scrn	ClrT, ClrG, DispT, DispG	4
Stat	Stat x/xw/xy/xyw. Data, St	6
Stat graph	G(hist), G(B.L.), G(C.F.), G(N.D.), G(S.D.), G(B.C.)	6
Reg graph	G(line), G(exp), G(ln), G(log), G(pow), G(inv)	6
Save program	99 programs	1

Option

Operation	Туре	Total
Screen and Memory	LCD contrast, Memory check	2
Data management	Copy, Move, Del	3
Data/Printer	Screen×1, Screen×2, List/Data	
Data communications	Send, Send all, Backup	0

Total functions

408

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